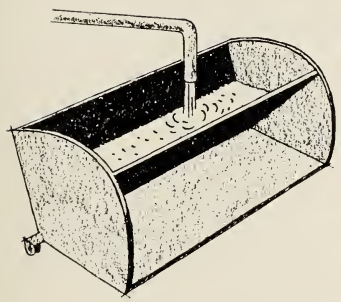
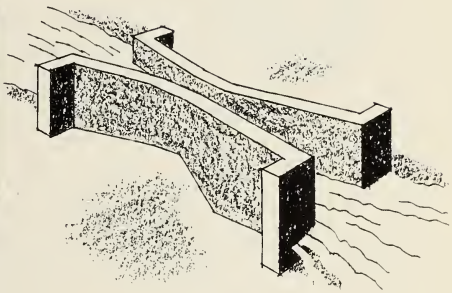
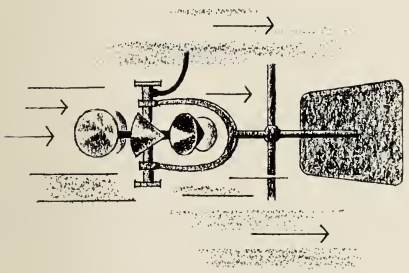
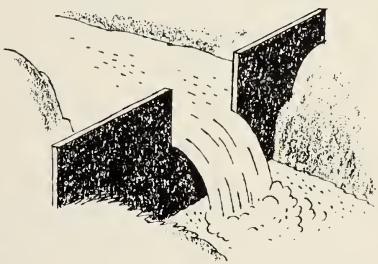
Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

MEASURING IRRIGATION WATER









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CLYDE E. HOUSTON

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

CIRCULAR 473

easuring irrigation water is important as local and regional water shortages become more widespread, and efficient water management on the farm becomes a must.

ccurate water measurement of irrigation water is necessary to assure proper distribution of surface supplies according to rights, shares, or quantities ordered, and to maintain efficient performance of wells and pumps.

pplying the proper amounts of water helps
produce maximum growth yields;
prevent poor growth because of insufficient water;
reduce drainage problems because of too much water.

THIS CIRCULAR describes some of the most common devices and methods of measuring water. It contains drawings, tables, and charts to help you quickly determine rate of flow. It lists some advantages and limitations, but it is impossible to mention all that may apply to any given situation. In fabricating, installing, operating, and maintaining water-measuring devices, follow recommended procedures, or gross errors in measurement may result. The illustrations show the general types of equipment, and are not construction drawings. For design details and the hydraulics of measuring devices, consult a textbook on hydraulics.

The Authors:

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JANUARY, 1959

Measuring Irrigation Water

Verne H. Scott

Clyde E. Houston

Methods of Measuring Water

Methods of measuring water can be grouped into three categories:

Direct methods (pages 3 to 4).

Velocity-area methods (pages 5 to 12).

Methods employing a formed constriction in the cross section of the ditch or pipeline (pages 13 to 19).

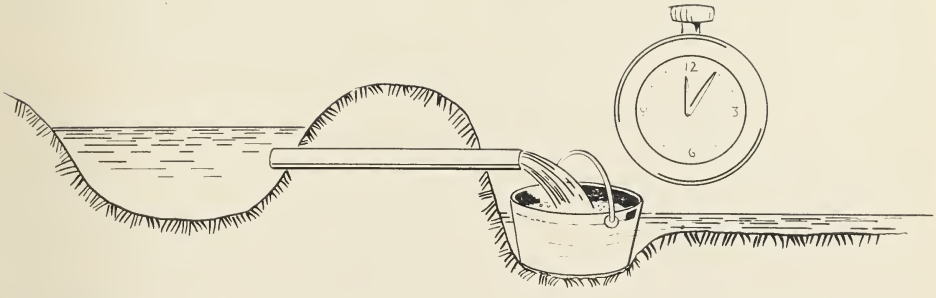
Direct Methods

Using a container

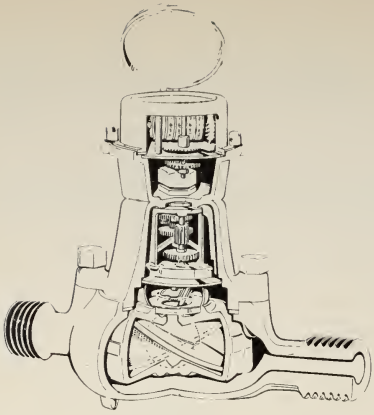
Collecting water in a container of known volume for a measured period of time. This method can be used to determine the rate of flow of small streams such as irrigation furrows. To measure the volume you may use a one- or five-gallon bucket. Noting the time needed to fill it to the top will give you the rate of flow.

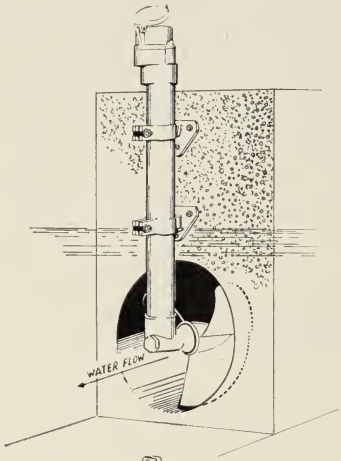
Measuring the change in the water level of a reservoir

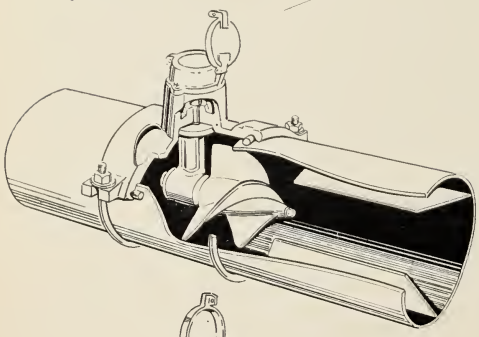
A direct measurement of the flow rate into or out of a reservoir can be made by measuring the change in the water level for a given period of time, providing the dimensions of the reservoir are known. You will obtain reliable results if the reservoir is lined to prevent seepage loss; otherwise you must estimate the seepage.

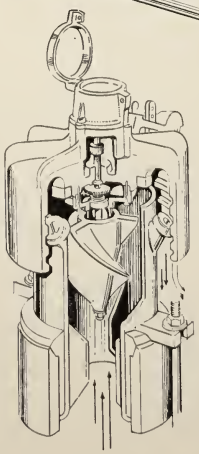


Collecting a known volume of water in a measured interval of time is a useful method of determining flow rate of small streams such as irrigation furrows.









Direct volumetric measurement

Several types of water meters operating on this principle are shown on this page. The first is a disk-type commercial meter frequently used with small-diameter pipe to measure volume of water to urban residences. This type of meter normally totalizes the volume of flow on a register mounted on top of the meter. The other three are commercial water meters utilizing a propeller; they are available for installation in pipe lines or vertical riser pipes. Usually the propeller is slightly smaller than the inside pipe diameter, thus assuring a constant cross-sectional area. A register on top of the meter indicates the total volume of water that has passed through the meter, or an indicator can be supplied on some models to show instantaneous rates of flow. With this type of meter, watch out that no debris is deposited on the propeller.

Tilt bucket

A tilt bucket consists of a balanced, two-compartment, sectioned tank. When one compartment fills to a known volume, the tank tilts, causing the filled compartment to empty while the other side is brought into position to fill. A counting mechanism totalizes the number of tilts, and permits calculation of the total volume of water passing through the tilt bucket. This type of measuring device requires a situation where the water can be delivered at sufficient elevation above the bucket to permit the tilting.

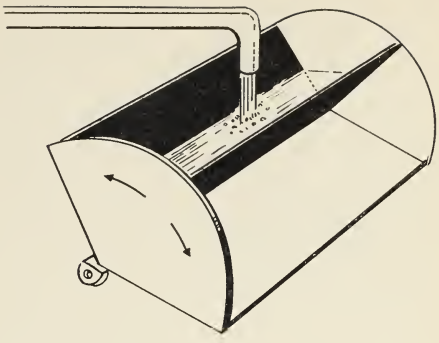
Four types of water meters using direct volumetric measurements: From top to bottom: 1. Disk-type residential meter, useful in small-diameter pipe. 2. Propeller-type irrigation meter at pipe outlet. 3. Propeller-type irrigation meter within pipeline. 4. Propeller-type irrigation meter for vertical riser pipe. The last three are commercial types.

Velocity-Area Methods

The rate of flow passing a point in a pipe, ditch or open channel is determined by multiplying the cross sectional area of water at right angles to the flowing water by the average velocity of the water. Normally you can determine the cross sectional area by direct measurement. But watch out for irregularities in the bottom and sides of the channel.

Determination of the velocity is more difficult, since in most ditches and canals the velocity differs considerably at various points within the cross section.

Always use the same units for the cross sectional area and the velocity when multiplying them to obtain the rate of flow. For example, if the cross sectional area is determined in square feet and multiplied by the average velocity in feet per second, the rate of flow will be cubic feet per second.



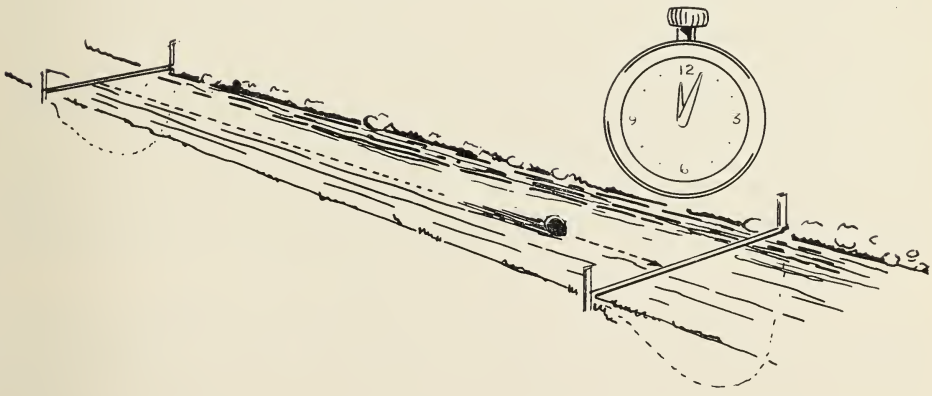
Two-way tilt bucket may be used where water drops from some height to permit tilting.

Float method

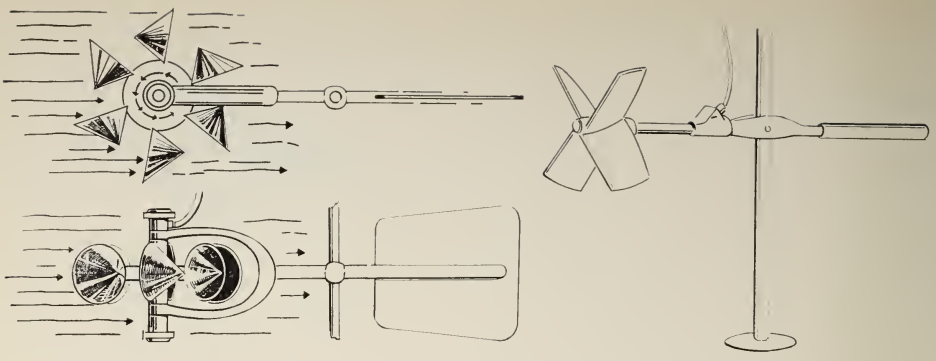
The float method gives you an approximate measure of the rate of flow. It is useful when more costly installations are not warranted or high accuracy is not required.

Select a straight section of ditch with fairly uniform cross-sections. The length of the section (about 50 or 100 feet) will depend on the current. Make several measurements of depth and width within the trial section, to arrive at the average cross section area. Stretch a string or tape across each end of the section at right angles to the direction of flow. Place a small float in the ditch, a few feet upstream from the upper end of the trial section. Record the time the float needs to pass from the upper to the lower section. Make several trials to get the average time of travel.

To calculate the velocity in units of feet per second, divide the length of the



Float method for determining rate of flow is inexpensive though not too accurate.



Current meters are accurate, usable in ditch or channel. Two meters are popular in California: Price current meter (left) and Hoff current meter (right).

section (in feet) by the time (in seconds) required for the float to travel that distance. Since the velocity of the float on the surface of the water will be greater than the average velocity of the stream, it is necessary to correct the measurement by multiplying by a coefficient—usually .80.

To obtain rate of flow, multiply this average velocity (measured velocity × coefficient) by the average cross sectional area.

Among small objects which make good floats are a long-necked bottle partly filled with water and capped, a block of wood, an orange or a lemon.

Current meter method

A current meter accurately determines the velocity in a ditch or channel. It is a small instrument containing a revolving wheel or vane that is turned by the movement of the water. Of the types available, the two most common in California are the Price meter and the Hoff meter. (See drawings above.)

The Price current meter contains an impeller which consists of six conical-shaped cups mounted on a vertical axis. When the meter is immersed in moving water, the impeller revolves, and the time for a given number of revolutions is determined by the operator. The completion of every revolution or every fifth revolution is indicated by an electrical sounding device connected to earphones which the operator wears.

The Hoff meter contains a rubber impeller mounted on a horizontal axis. Its chief advantage is that it is less affected by eddies, or turbulence. It has been used for measuring the velocity of water flowing from the end of the discharge pipe of pumping plants.

Current meters are either mounted on a rod, or suspended on the end of a cable above a heavy weight. Use rod mountings in measuring shallow streams that can be waded. For deep streams or for measurements from a bridge or cableway some distance above the water surface, use the cable suspension.

Before being used in the field, current meters are rated or calibrated to determine the relation between the speed of rotation of the impeller and the velocity of the water. From this rating a graph or table is prepared showing the velocity for a given number of revolutions in a given time interval.

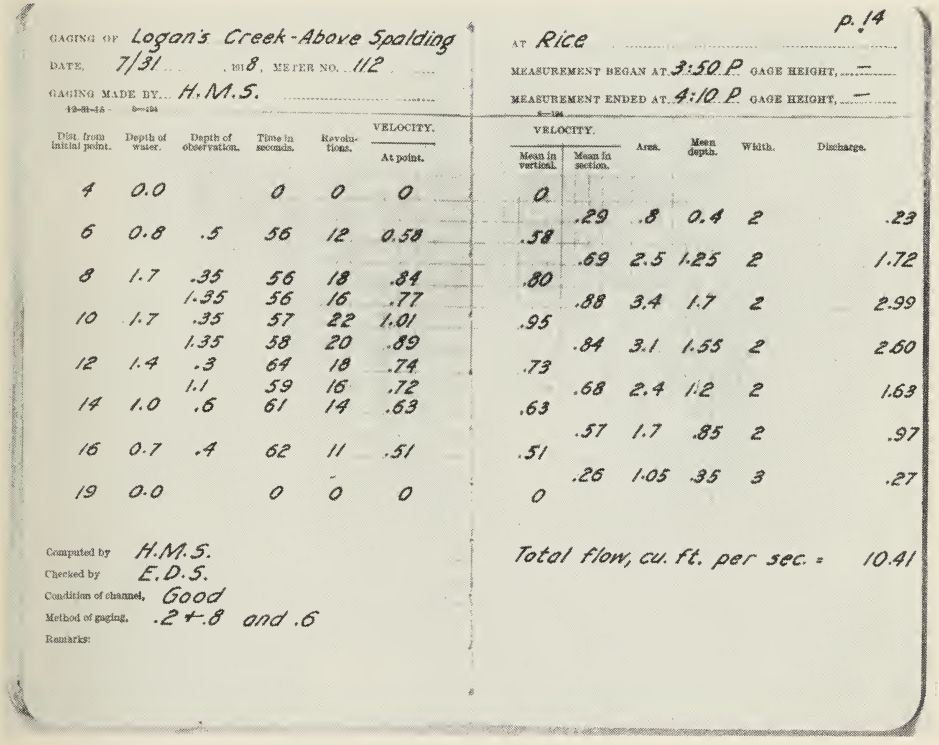
Current-meter measurements are generally made by trained hydrographers or by engineers familiar with this work. These persons are continuously carrying on research to develop newer methods and more accurate procedures.

Here are a few facts useful to know for anyone:

The channel at the measuring section should be straight, with a fairly regular cross section. When possible, avoid structures with piers in the channel. Several measuring points are laid off across the stream at right angles to the direction of flow. These are generally spaced an equal distance apart, not more than the mean depth of the channel nor more than 10 per cent of its width, making a total of not less than 10 measurements. On wide streams an interval of 10 feet is ordinarily used. The depth and mean velocity of the stream are then determined at each measuring point.

Four methods are generally acceptable for determining the mean velocity with a current meter: multiple-point, two-point, single-point, and vertical integration.

The **multiple-point,** being the most accurate, is the method by which the accuracy of other methods is generally checked. At each measuring point the velocity is determined at several closely spaced points from the bottom of the channel to the water surface. If these are equally spaced, the mean velocity in the vertical approximates the average of the measured velocities. This method is seldom used in irrigation practice because it is time consuming.



GAGING OF Logan's Creek - Above Spalding AT Rice p. 14

DATE 7/31 1918, METER NO. 112

GAGING MADE BY H.M.S.

MEASUREMENT BEGAN AT 3:50 P. GAGE HEIGHT, —

MEASUREMENT ENDED AT 4:10 P. GAGE HEIGHT, —

Dist. from initial point.	Depth of water.	Depth of observation.	Time in seconds.	Revolutions.	VELOCITY. At point.	VELOCITY. Mean in vertical.	VELOCITY. Mean in section.	Area.	Mean depth.	Width.	Discharge.
4	0.0		0	0	0	0					
6	0.8	.5	56	12	0.58	.58	.29	.8	0.4	2	.23
8	1.7	.35	56	18	.84	.80	.69	2.5	1.25	2	1.72
		1.35	56	16	.77		.88	3.4	1.7	2	2.99
10	1.7	.35	57	22	1.01	.95					
		1.35	58	20	.89		.84	3.1	1.55	2	2.60
12	1.4	.3	64	18	.74	.73					
		1.1	59	16	.72		.68	2.4	1.2	2	1.63
14	1.0	.6	61	14	.63	.63					
							.57	1.7	.85	2	.97
16	0.7	.4	62	11	.51	.51					
							.26	1.05	.35	3	.27
19	0.0		0	0	0	0					

Computed by H.M.S.

Checked by E.D.S.

Condition of channel, Good

Method of gaging, .2+.8 and .6

Remarks:

Total flow, cu. ft. per sec. = 10.41

Typical current-meter notes illustrating the method of recording the data and computing the flow. For each section between two measuring points, the area is taken as the product of the average depth and width; the mean velocity as the average of the mean velocities in the two vertical sections; and the flow as the product of the area and mean velocity. The total flow is the sum of the flows between the sections.

In the **two-point method,** the velocity is determined at 0.2 and 0.8 of the depth. The average of these two measurements approximates the mean velocity for ordinary conditions.

In the **single-point method,** the velocity is determined at a point .6 of the stream depth below the water surface. This method is generally employed at depths less than one foot which is insufficient for the two-point method.

In the **vertical-integration method** the meter is lowered and raised at a uniform rate in each of the selected verticals in the measuring section. Due to the possibility of introduction of errors this method is seldom used in routine stream gaging.

Tracer methods

Dyes or salts are injected into a stream at a given point and detected downstream; just as with floats, the velocity is computed from the time the tracer travels down a known distance. Upon injecting a small amount of concentrated dye or salt solution; the dissolved material soon spreads throughout the stream because of turbulence, and extends along the reach of the stream for some distance. Therefore, you must determine the time that the first and last portions of the tracer arrives at the detection point, and use the mean of these times to compute the average velocity of the stream.

Dyes are preferred because they can be seen readily. Suitable dyes are fluorescein and potassium permanganate. Salts require an instrument to indicate their presence.

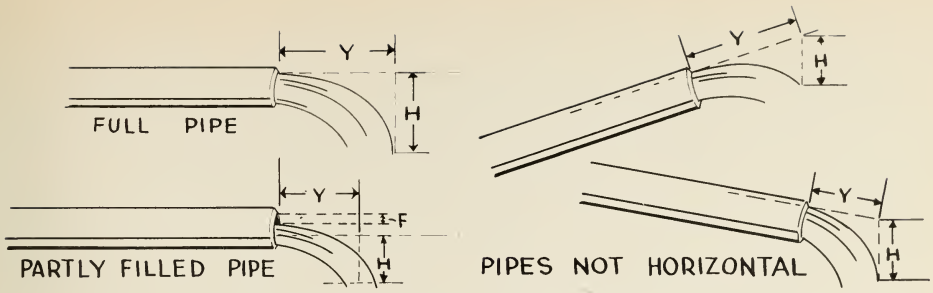
Once the average velocity is determined, you again can calculate the rate of flow by multiplying average velocity by the average cross section area. No coefficient of 0.8 (as in the float method) is needed.

The dye method is also good for determining velocities in pipe lines. Inject a small quantity of the dye solution into the water at the intake of the pipe line or at some point along the line. Check time at the instant the coloring matter is introduced and at its first and last appearance at the second point of observation, usually at the outlet of the pipe. To find mean velocity divide the distance in feet by the average time in seconds required for the color to pass through the pipe. To determine flow rate multiply the velocity by the cross sectional area of the pipe.

Trajectory method

This method determines the rate of flow discharging from the end of a pipe. Use two measurements of the jet discharging from the pipe to calculate the velocity of the water. To determine the rate of flow, measure the area of the jet at the end of the pipe and multiply by the velocity.

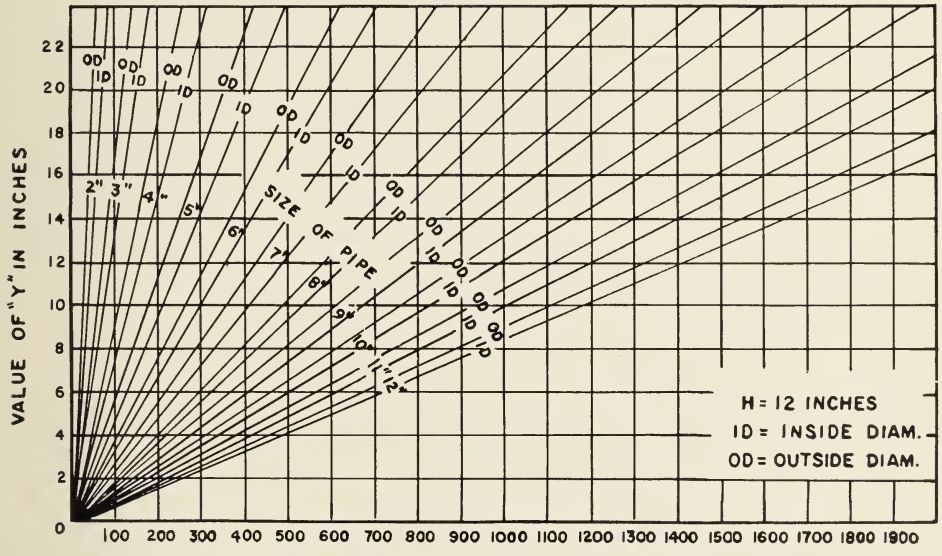
Tracer method determines rate of flow like the float method, needs no coefficient, can be used in pipelines.



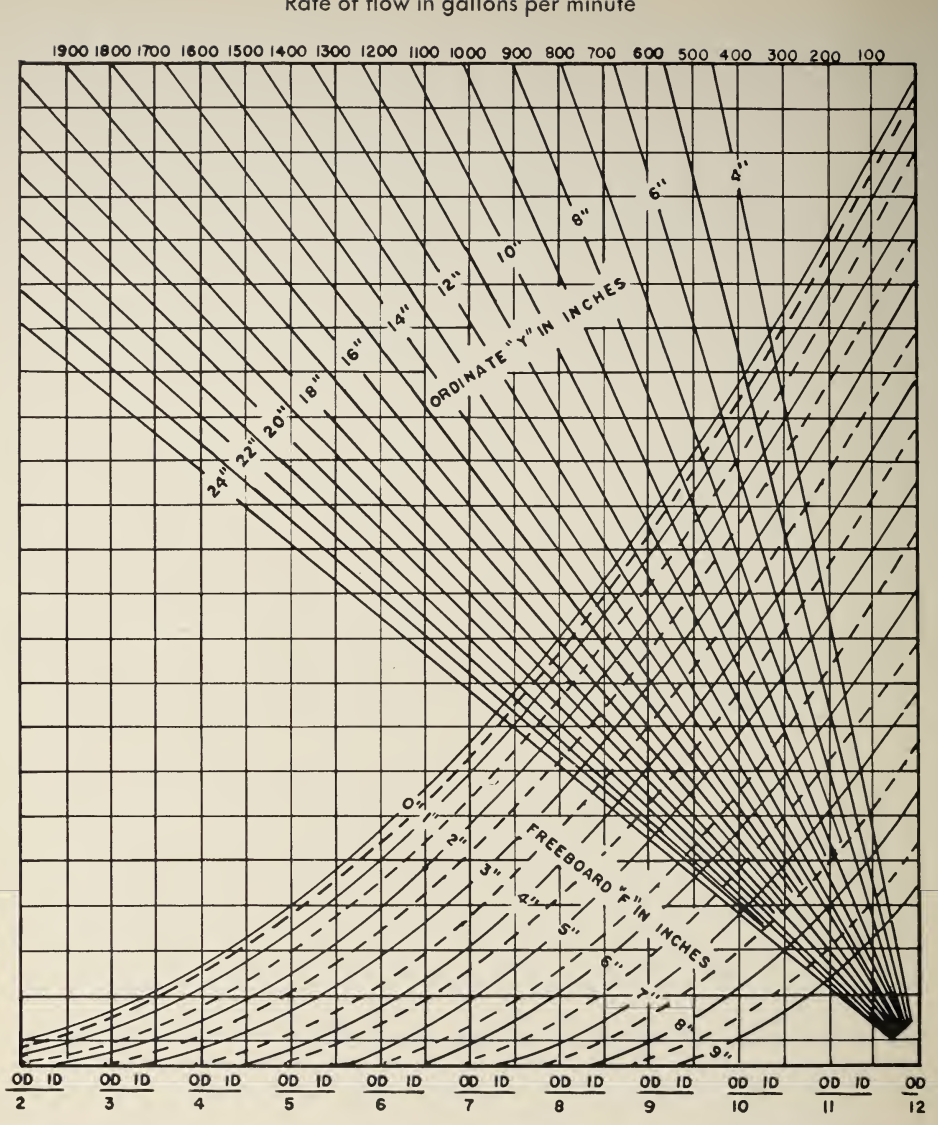
For trajectory method find value of Y. Measure H as 12 inches, in full pipes from top of jet, in partly filled pipes from center of jet. For partly filled pipes measure also freeboard F. Then use found values in diagrams on this and the next page.

For pipes flowing full make the horizontal and vertical measurement on the upper surface of the jet; for partly filled pipe make the measurements at the centers of the jet, as shown in the drawings above. By using 12 inches as the value of the vertical distance (H) in field measurements, the values of rate of flow may be obtained from the diagrams. For pipes flowing partly full the amount of "freeboard" (F) must also be measured.

For full pipes use diagram on this page and for partly full pipes that on page 10. In either case when H equals 12 inches in the field measurement and using the measured value of Y and the diameter of pipe, the rate of flow can be read directly. When H equals 6 inches, multiply the reading on the rate of flow scale by 1.4 to obtain the correct discharge.



TO DETERMINE RATE OF FLOW FOR FULL PIPES by the trajectory method start at value of Y on the left, move horizontally to intersection with diagonal line for size of pipe, then vertically down to find rate of flow in gallons per minute.



TO DETERMINE RATE OF FLOW IN PARTLY FULL PIPES, begin with pipe size at bottom, move vertically to intersection of curve with proper freeboard, F, then across horizontally to diagonal line giving ordinate Y in inches, then vertically to top to find flow rate in gallons per minute.

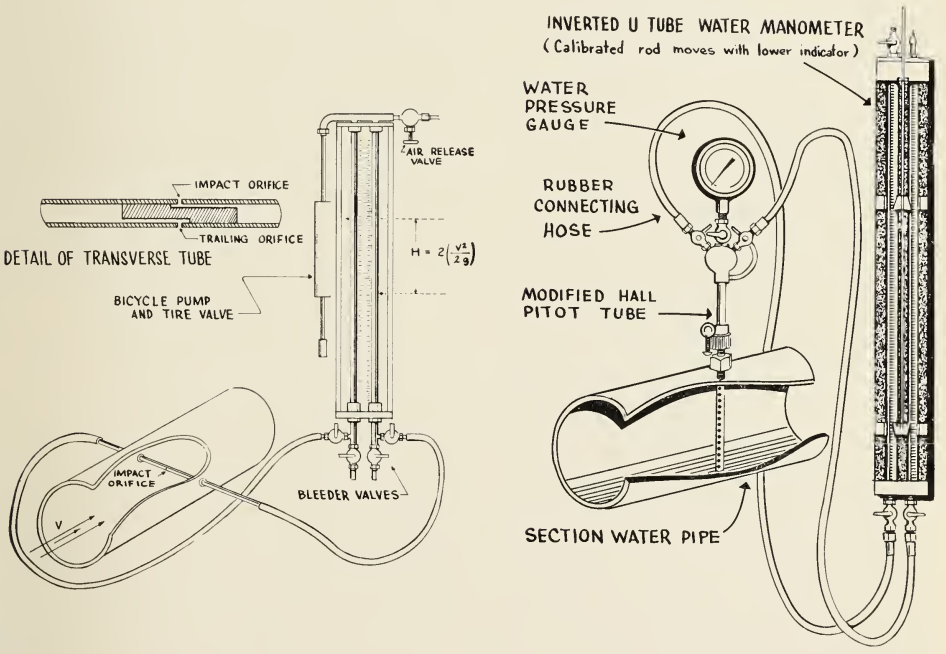
Pitot tube method

A simple pitot or impact tube is a small diameter L-shaped tube with both ends open. When immersed in a stream with the lower open end facing the current and the other end open to the atmosphere, the water will rise in the tube a small distance above the water surface of the stream, this distance being equal to

the velocity head, or $V^2/2g$. Pitot tubes are used primarily for measuring the flow of water in pipes because the velocities encountered in open channels are usually too low to permit accurate measurement. When used in pipes it is also necessary to determine the static head, so that either a static piezometer connection must be made in the wall of the pipe, or a combined pitot-static tube is used. This type is usually L-shaped with small holes along the side of the tube about midway between the open tip and the stem to measure the static head. Several standard types of pitot-static tubes have been developed and carefully tested to determine their specific characteristics and limitations.

Another form of pitot tube has an open stem projecting upstream and one projecting downstream. In this case the total measurable head is somewhat greater than the velocity head, and an appropriate coefficient is used to obtain the velocity. The Cole pitometer is an instrument of this type, and the value of the coefficient for this instrument has been found to vary from about .86 to .89.

The transverse tube is another form of impact tube. This consists of a small diameter tube with a small hole or orifice drilled into the side. This tube is inserted through holes in opposite sides of the pipe with the orifice facing upstream where the pressure head is equal to the static head plus the velocity head. When the tube is rotated so the orifice faces downstream, the measured pressure head is essentially equal to the static head less the velocity head. A transverse tube can, therefore, be constructed with two orifices, one on each side of the tube, leading to different ends of the tube. The total differential head thus measured is essentially equal to twice the velocity head. *The Collins Flow Gage* shown in



Two types of pitot tubes: the Collins flow gage (left) used to measure discharge of pumping plants; and the Cox Flowmeter (right) which permits a reading of velocity with a single measurement.

the drawing on page 11 is an instrument of this kind consisting of an impact tube and a water air manometer. It is extensively used by one of the electric power companies in California for measuring the discharge of pumping plants.

The Cox Flowmeter, page 11, consists of a Hall tube which is designed to integrate the velocities across the pipe, and a special water-air monometer. This makes it possible to obtain the mean velocity with a single measurement. The manometer can also be used with other forms of pitot tubes, such as the Prandtl tube, a conventional type of pitot tube, which can be furnished by the same company.

How to calculate flow. Since most forms of pitot tubes measure the velocity only at one point in the cross section of the pipe, there are different procedures for obtaining the mean velocity, and hence the flow.

The simplest, but least accurate, method is to place the pitot tube in the center of the pipe where the velocity is usually a maximum, and to apply a coefficient to obtain the mean velocity. Since the ratio of maximum to mean velocity is affected by many factors, precise measurements are not possible with this method. Tests by the University of California, Davis Campus, on transverse pitot tubes (Collins) have indicated that the velocity determined at the center should be multiplied by a factor of about .94 to obtain the mean velocity. This is a higher coefficient than generally assumed for the ratio of mean velocity to center velocity in a pipe line, and may not apply to other types of pitot tubes.

Somewhat better accuracy can be obtained by taking the velocity at two points, one on each side of the center, at positions where the velocity is approximately equal to the mean velocity. It has also been found with transverse tubes that the mean velocity determined at two points gives approximately the mean velocity. These two points are .39 of the diameter on each side of the center of the pipe. Collins suggests that such measurements be made at points .354 of the diameter on each side of the center of the pipe.

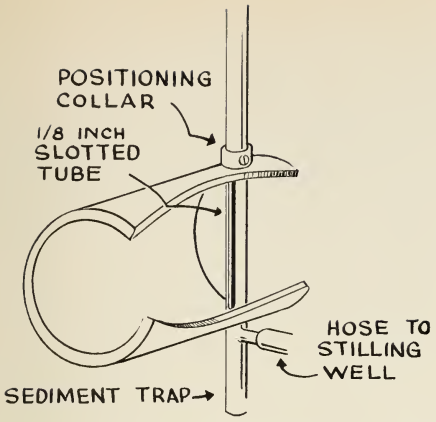
Still better accuracy can be obtained by making a velocity traverse across the diameter of the pipe. For highest precision traverses are made across two, or even four diameters, and up to ten measurements may be made on each diameter. The points are usually taken so that each represents the mean velocity for concentric rings of equal area. For a ten point traverse, measurements should be made at points .158, .274, .354, .418, and .474 of the diameter from the center of the pipe on each side of the center. For a six-point traverse the positions would be .204, .354, and .456 of the diameter from the center.

The accuracy of any pitot tube measurement will depend upon (a) the accuracy of calibration of the instrument, (b) the number of points at which observations are made, and (c) the precision with which all measurements are taken, including the manometer readings. Very accurate results are possible when the characteristics of the pitot tube are known and all measurements are carefully made.

Some tests by the University of California at Davis have indicated that the best results under unfavorable flow conditions, as near an elbow, gate valve, or pump, can be obtained with the transverse tube (Collins tube).

Slotted tube method

Recent studies at the University of Minnesota indicated that a slotted tube mounted at or near the end of a discharge pipe with the slot directed upstream can be calibrated and used to measure the rate of flow from a partially full pipe. Arrangement of parts and important dimensions for use of the device in smooth-wall pipes of various diameters are shown in the drawing on page 13.



Slotted tube, mounted near end of discharge pipe may be used to measure flow rate from partially full pipe.

The water level in the slotted tube, measured from the bottom of the pipe, is used as an index of the velocity. For convenience and greater accuracy, the water level is measured in a stilling well which is connected by a hose to the lower end of the tube. The water level can be measured manually with a tape or hook gage, or if a continuous record of the flow is needed, by means of a water stage recorder.

Flow rates in three sizes of pipes for various gage heights can be found in Table 1, page 25. For other sizes of pipes with diameters within a range of 6 to 12 inches, see Table 2, page 25.

Methods Employing a Formed Constriction

Methods employing a constriction of predetermined dimensions are most commonly used in measuring irrigation water. In general, only one or two simple measurements are required if the dimensions of the constriction are known. In most cases a table or graph is available for rapid determination of the flow rate.

Weirs

A weir is a notch of regular form through which water may flow. Weirs are classified according to the shape of the notch; the type of crest; and whether they are contracted or suppressed. Examples of weirs classified according to the shape of notch are: the rectangular contracted weir, the V-notch weir, the Cippoletti weir, and the rectangular suppressed weir.

Types of weir according to crest are: the sharp crested weir, having a sharp upstream edge so formed that the water, in passing, touches only a line; and the broad crested weir, having either a rounded upstream edge or a crest so broad that the water, in passing, comes in contact with a surface. The sharp crested weir, because of its greater accuracy, is used almost exclusively for measuring water in a canal or ditch.

Contracted weirs are those where the crest length is less than the width of the upstream channel; suppressed weirs are those where the crest length is equal to the width of the approach section in the upstream channel.

Avoid submerged weirs (where the elevation of the downstream water surface is higher than the crest of the weir) because additional measurements are required to correct the velocity.

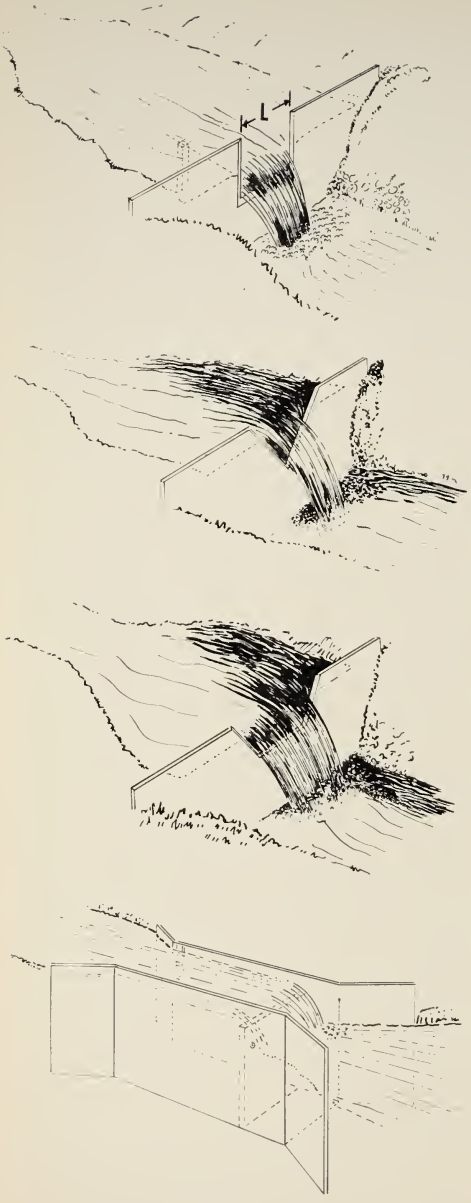
How to install a weir. The weir, when properly constructed and installed, is one of the simplest and most accurate methods of measuring water. Under ideal conditions it will be accurate within 2 or 3 per cent; under most field conditions you may expect accuracy within 5 to 15 per cent. You can easily and cheaply construct and install a weir by following these simple instructions:

Set the weir structure in a channel that is straight for a distance upstream from the weir equal to at least ten times the length of the weir crest.

Place the weir at right angles to the direction of water flow.

Make sure the face of the weir structure is perpendicular, and the weir crest straight and level.

Avoid obstructions on the upstream side of the weir structure.



Four types of weir used in California. From top to bottom: 1. rectangular contracted weir, simple and easy to construct. 2. V-notch weir, accurate at very low flow. 3. Cipoletti weir, not as practical as rectangular weir. 4. Rectangular suppressed weir, useful for measuring water in rectangular flume.

Make the crest and sides of the weir notch not more than one-eighth of an inch in thickness.

If possible, set the weir structure at the lower end of a long pool sufficiently wide and deep so that the water will approach the weir free from eddies, at a velocity not exceeding .5 foot per second.

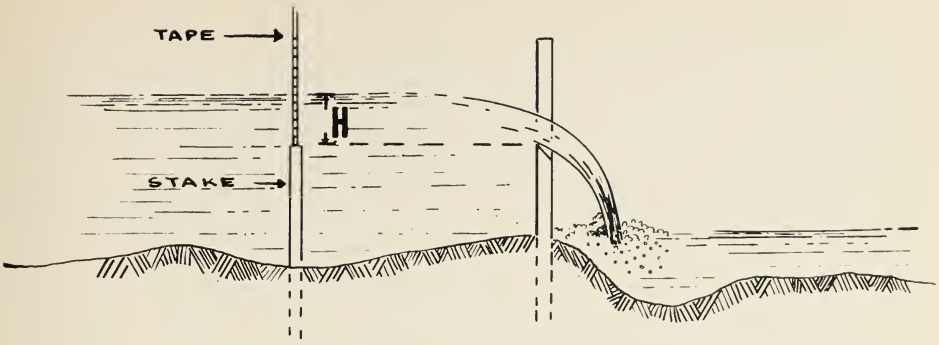
The height of the crest of the weir above the bottom of the channel, upstream from the weir, should be at lease twice, and preferably three times, the depth (or head) of the water flowing over the crest. Remove debris accumulating behind the weir.

The distance from the side of the weir notch to the sides of the channel or weir box (except for a suppressed weir) should be at least twice the depth (or head) of water passing over the crest.

See to it that the length of the weir crest is such that the head to be measured exceeds two inches and the maximum head, preferably is not greater than one-third the length of the weir crest.

Construct the crest of the weir in a manner that air can circulate freely beneath the overflowing water.

Measuring the head on a weir. Measure the head or depth of water passing over the weir crest at a point upstream from the crest where the surface drawdown curve does not affect the measurement. You can do this by driving a stake in the pool at a distance upstream at least six times the maximum head on the weir. Have the top of the stake level with the weir crest. The distance from the top of the stake to the water surface is the head and is measured with a scale. For easier observation you may install a staff gage at the proper place in the pool, with the zero on the gage level with the weir crest. You then may make direct depth readings. For greater accuracy use a hook gage and stilling well.



Measuring head on a weir. Measure upstream from downward curve of the water surface.

Rectangular contracted weirs. The rectangular contracted weir takes its name from the location and shape of the opening through which the water flows. It was one of the earliest forms used, and from it all other types have been developed. Because of its simplicity, easy construction, and accuracy when properly used, it is still one of the most popular weirs. Table 3 on page 26 gives the flow over this type of weir in cubic feet per second.

V-notch weirs. The 90-degree triangular or V-notch weir has a greater practical range of capacity than any other type of a given size. Since, however, it requires a greater loss of head, it is better adapted to measuring flows not exceeding 4 cubic feet per second. Due to its shape it is relatively accurate at very low flows. Its shape makes it easy to construct and install with the aid of a carpenter's square and level. Table 4, page 30, gives the flow for this weir in cubic feet per second and gallons per minute.

Cipolletti weirs. This is a contracted trapezoidal weir in which the sides of the notch slope at the scale of one horizontal to four vertical. The discharge through the triangular portions at the ends of the weir opening is equal to the decrease in discharge resulting from end contractions. Table 5, page 33, gives the flow over Cipolletti weirs in cubic feet per second.

Rectangular suppressed weirs. Having no end contractions, and only bottom contraction, a suppressed weir may be in the form of a flume of uniform cross section, with a vertical weir plate installed near the end. The length of the flume should be at least ten times the length of the weir crest in order to remove turbulence in the approach section. Provide ventilation under the water falling over the crest, for instance by drilling a small hole on each side of the flume below the downstream edge of the weir crest. The height of the crest above the floor of the weir structure or bottom of the channel should be at least equal to the maximum head to be measured. For good results the head measured should not be greater than 2.0 feet or smaller than .2 foot.

Table 6, page 37, gives discharges for a weir length of one foot for various weir heights of weir crest above the bottom of channel of approach. For different crest lengths multiply discharges as given for head and weir height by length of weir crest used in feet.

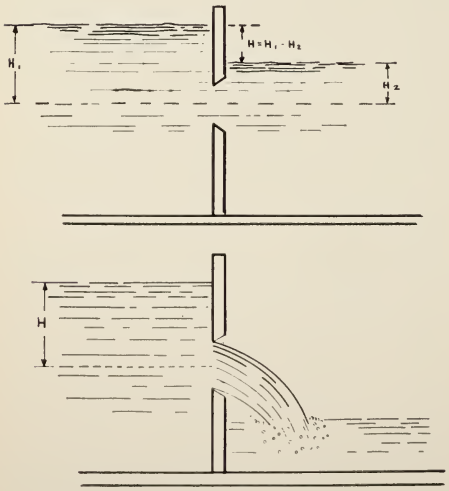
Limitations in the use of weirs. Weirs, while easy to construct and convenient to use, may not always be suitable. They are not accurate unless proper conditions for weir measurements are

maintained. Deposition of silt and debris in the stilling basin of the approach section will reduce the accuracy of the measurements. They require a difference in elevation between the water level on the upstream and downstream side of the weir, which sometimes is not easily available in ditches on flat grades.

Orifices

Orifices in open channels are usually circular or rectangular openings in bulkheads placed across the stream. The edges of the openings are sharp and often constructed of metal. The cross-sectional area of the orifice is small in relation to stream cross-section. These conditions allow complete contraction of the streamflow, and the velocity of approach becomes negligible.

Free flowing and submerged orifices. Under free-flow conditions the flow from the orifice discharges entirely into air. If the orifice is fully submerged, the downstream water level is above the top of the opening, and the flow discharges into water. The drawing below illustrates how measurement of head on submerged and free-flowing orifices are made.



Measuring head through orifice. Avoid orifices that do not flow free or under complete submergence.

Avoid partially submerged orifices—with downstream water level below the top of the opening but above the bottom. Complete submergence has little effect on the flow characteristics, but partial submergence makes the head measurement difficult.

The flow through different size orifices under different heads is given in Table 7 on page 41.

Miner's inch boxes. These are special forms of free-flowing orifices in which provision is made to maintain a constant predetermined head above the center of the orifice. Since a miner's inch (see box on page 22) is defined as the quantity of water flowing through an area one square inch in cross section under a prescribed head, it is only necessary to maintain this head and measure the area of the orifice in square inches. This area is numerically equivalent to the discharge in miner's inches.

Commercial head-gates

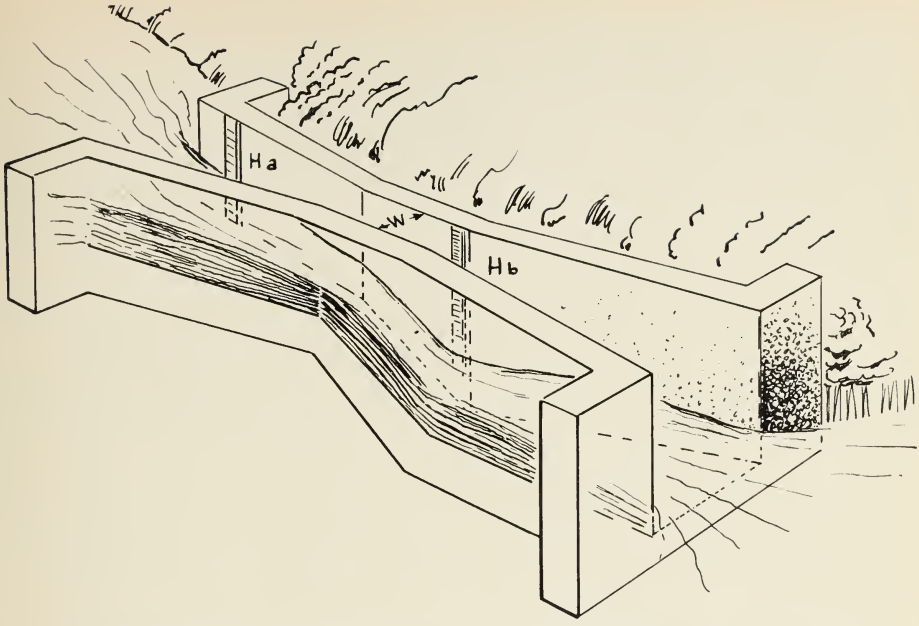
Commercial head-gates, used to control the quantity of water flowing from one ditch into another, may serve to measure the rate of flow, providing the head and area of opening can be determined and the gate has been calibrated.

The head is the same as that described for a free-flowing or submerged orifice.

Normally the gate and the opening into the outlet is circular, and the area can be determined easily if the gate is fully open. However, under most conditions the gate is only partially open, leaving a crescent-shaped area which is difficult to measure. Consequently, most gates are calibrated and tables supplied, giving the rate of flow as a function of the head and the degree of gate opening as measured by the displacement of the gate stem.

Parshall flume

The Parshall flume is a special type of critical flow meter, which is being used widely throughout most of the West. Ad-



Parshall measuring flume is self-cleaning, requires only a small drop, and works even when partly submerged.

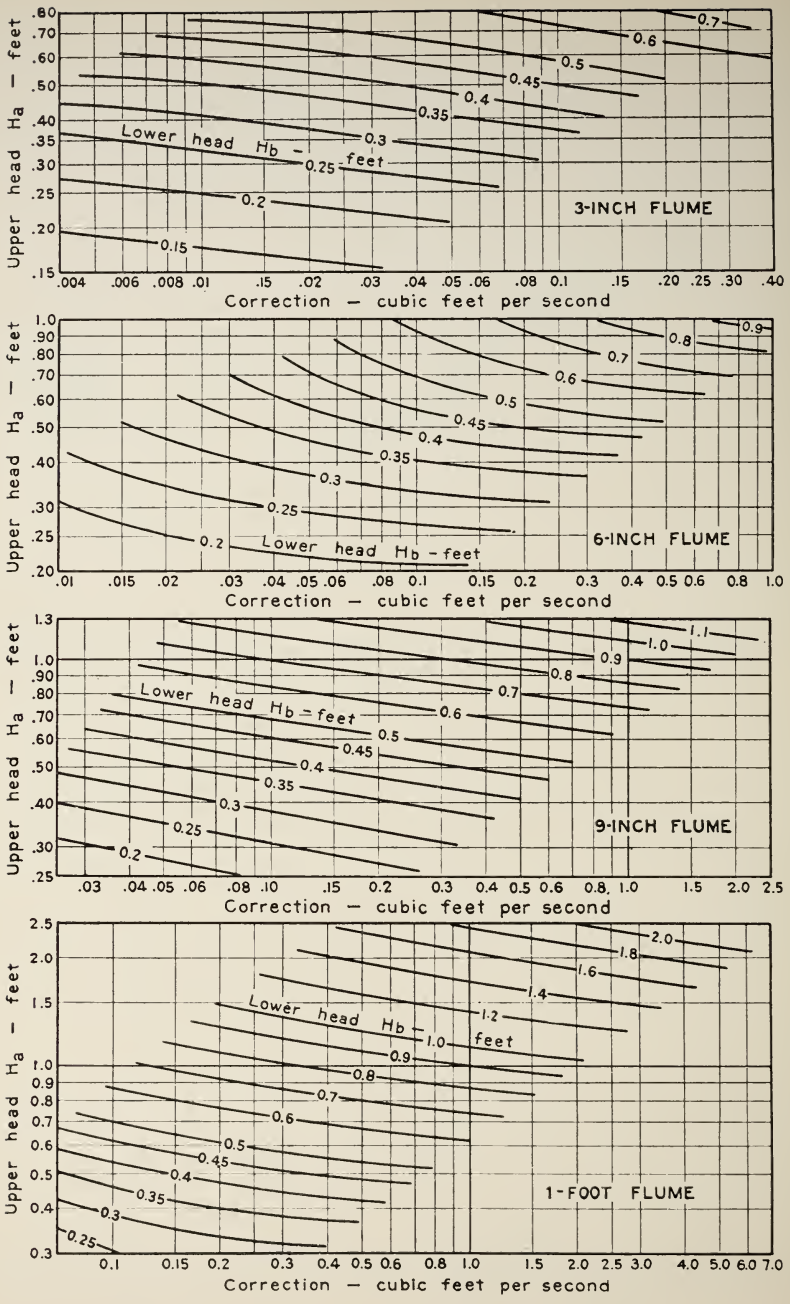
vantages: it is self cleaning, requires only a small amount of drop or head loss in the stream, and allows reasonably accurate measurement even when partially submerged.

The floor of the upsteam section is level and the walls converge toward the throat section. The walls of the throat section are parallel and the floor is inclined downward. The walls of the downstream section diverge toward the outlet and the floor is inclined upward.

The size of the flume is determined by the width of the throat of the flume. Sizes ranging from 3 inches to many feet in throat width have been calibrated and formulas and tables developed. Such flumes must be constructed with specified dimensions and the heads measured at designated points. Where there is considerable turbulence within the flume, use stilling wells for making accurate head measurements. Less accurate measurements may be obtained from staff gages attached to the sides of the flume at the designated points. Because variations in the elevation of the water surface in the stilling well are small, more accurate measurement of the water level can be obtained than is possible by measurements in the flume.

The successful operation of the Parshall flume depends upon setting the crest of the flume at the proper elevation above the bed of the channel. Where the canal has considerable slope and the banks are high, the flume can be installed with very little trouble. Where the banks are low and the canal has a flat grade, precaution must be taken in choosing the size and in setting the flume.

Free flow. The discharge through a Parshall flume is called "free flow" when the elevation of the water surface near the downstream end of the throat section is not high enough to cause any retardation of the flow due to back water. Under this condition only one measurement of the water level or head (H_a) in the converging section is needed to determine



Correction diagrams for determining submerged flow through Parshall measuring flumes. Subtract the amount obtained from this diagram from table 8 for the same upper head, H_a. For larger flumes, use diagram for the 1-foot flume and multiply correction by the factor given in table 9.

the rate of flow. Free flow discharge for various sizes of Parshall flumes is given in Table 8, page 44.

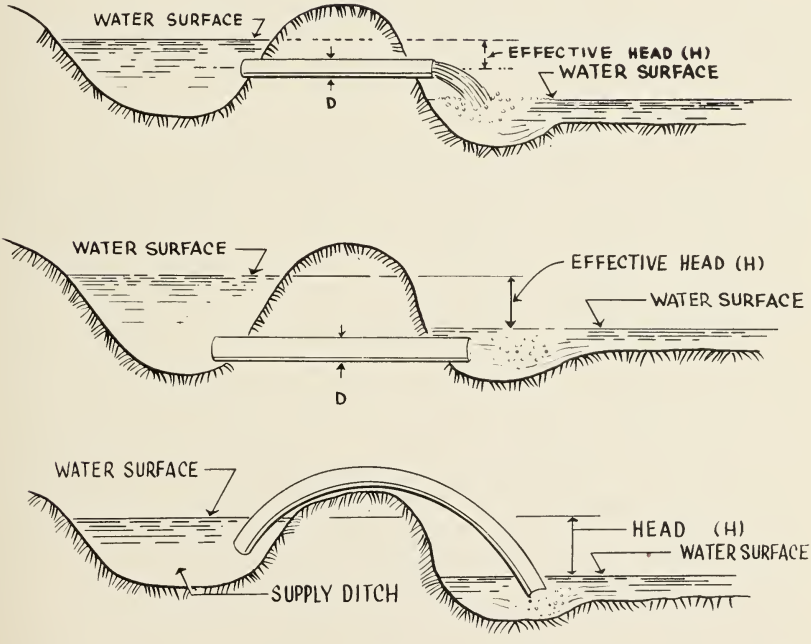
Submerged flow. Where the flow is submerged, it is necessary to install an "H_b" gage near the lower end of the throat section as illustrated in the drawing on page 17.

When the relation of the two heads, $\left(\frac{H_b}{H_a}\right)$, exceeds 0.7 a correction is subtracted from free flow conditions to obtain the correct rate of flow. This correction is determined by use of the charts on page 18. For large flumes multiply the correction for the 1-foot flume by the factor (M) given in a table on page 24. This value is then subtracted from the free-flow discharge to obtain the corrected flow.

Miscellaneous devices

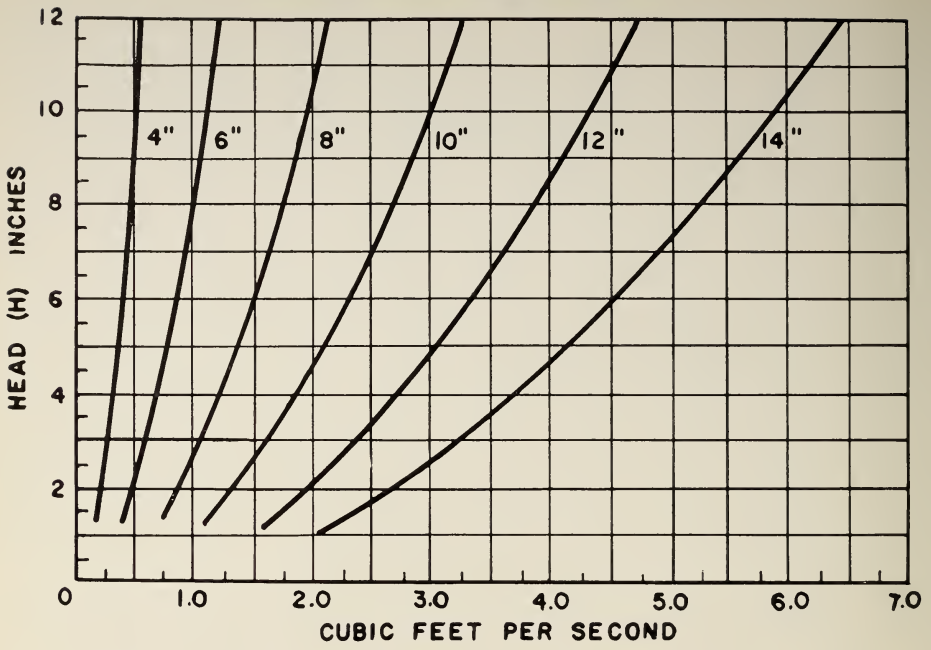
Small venturi flumes. In irrigation evaluation work it has been found advantageous to use a small Venturi flume to measure water in furrows. These flumes consist of only a converging section. Normally they are constructed of metal and require calibration to determine flow characteristics.

Siphons and pipe turnouts. Although siphons and pipe are used to deliver water from a ditch to a furrow or check, they can be used to measure the rate of flow being delivered. The drawing below shows the method of measuring the head. Once the head is determined the rate of flow can be found directly in the diagram on page 20 for pipe turnouts, in the diagram on page 21 for siphons.



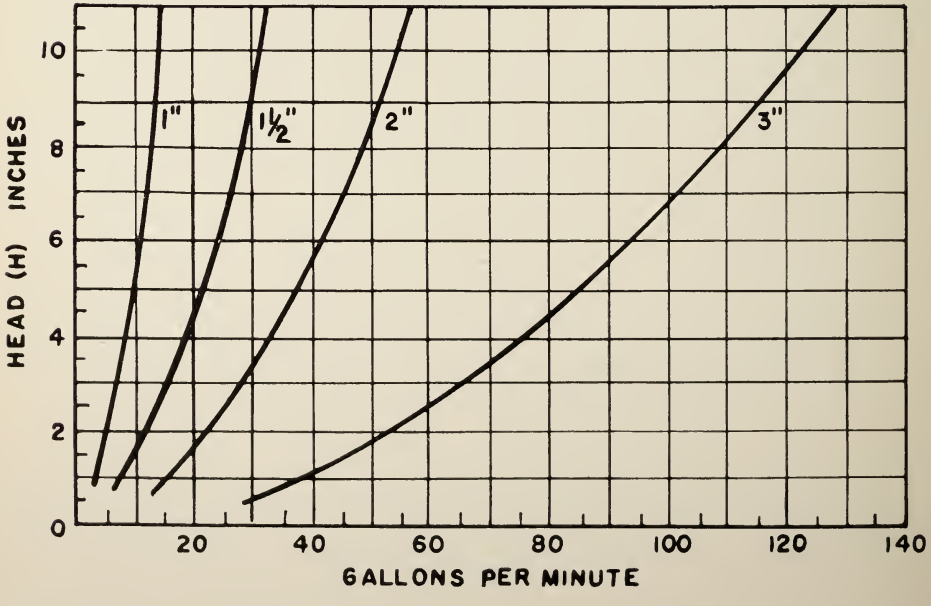
Measuring head on spiles and siphons. For free-flowing spiles (top) measure head as difference in elevation between water in the ditch and the center of the downstream end of the spile. For submerged spiles or siphons (center and bottom) measure difference in elevation of water in ditch and water in field.

Rate of flow through large pipe

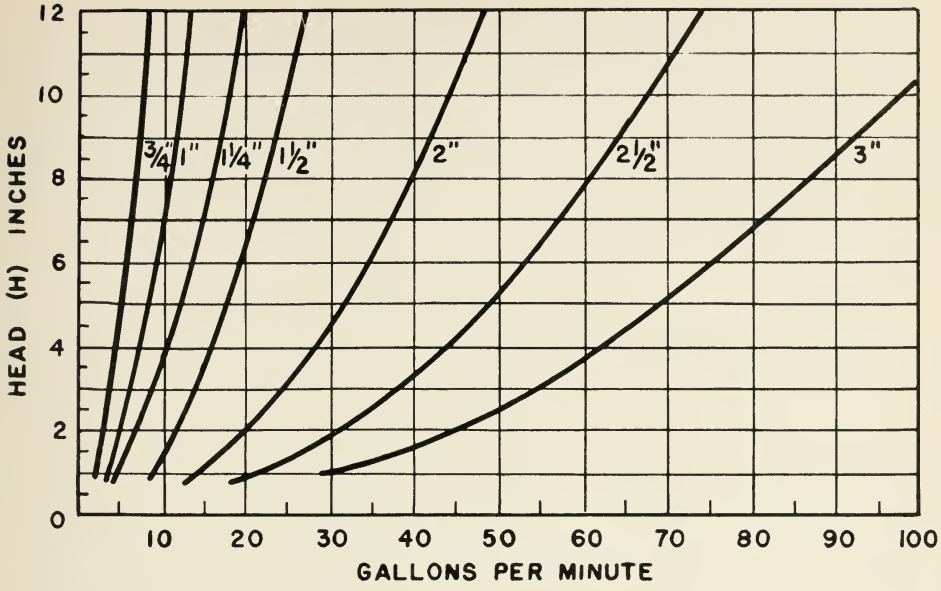


To determine rate of flow start at left, move horizontally from point of measured head to the size of pipe (or siphon), then vertically down to find rate of flow in cubic feet per second.

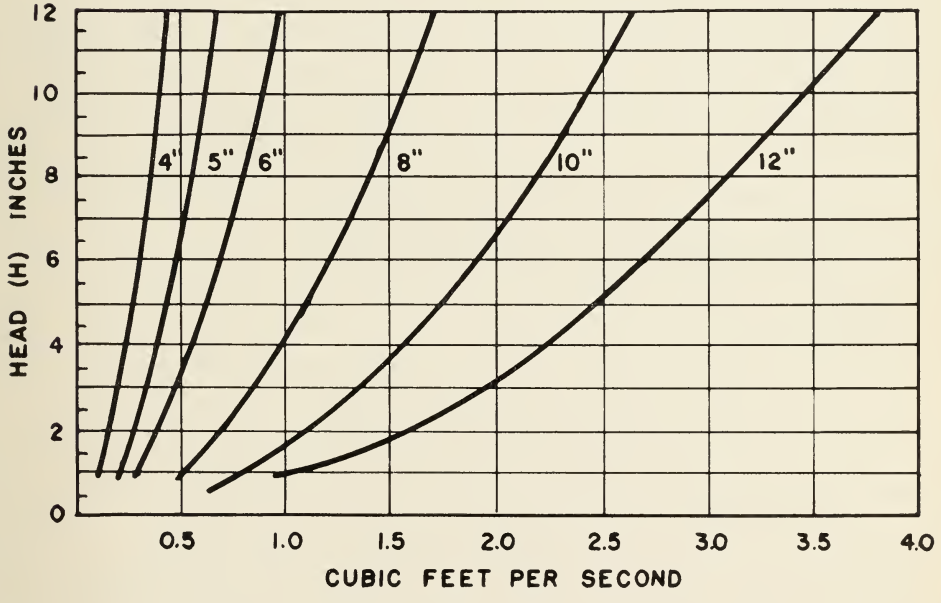
Rate of flow through small pipe



Rate of flow through small siphons



Rate of flow through large siphons



Units of Water Measurements

Irrigation water is measured in volume and flow units.

In some areas you want to know only the total volume of water used, as water is often purchased on that basis; in other cases it is important to know the rate of flow—the volume of water used during a certain time.

Volume units. The commonly used volume units include: cubic feet (cu. ft.), gallon (gal.), acre-inch (ac.-in.), acre-feet, (ac.-ft.), and miner's inch hours (M I-Hr.).

Flow units. The common units of flow are combinations of the above volume units with a convenient time unit. They are: cubic feet per second (cu. ft. per sec. or c.f.s.), gallons per minute (g.p.m.), acre-inches per hour, acre-feet per (24-hour) day, and miner's inches (M.I.).

Cubic foot per second, sometimes written second-foot (sec. ft. or cusec.), is the generally accepted standard unit of flow in the American system.

Gallons per minute is the most commonly used term for expressing flow from pumps.

A flow of one cubic-foot per second is approximately equal to one acre-inch per hour, 2 acre-feet per day, or 450 gallons per minute.

The miner's inch is an ambiguous measurement, and therefore not satisfactory as a unit for measuring flow. A brief survey of the variations of the miner's inch are given in the box on this page. If you use the miner's inch, state the head under which it is measured, or its equivalent in cubic feet per second.

What is a miner's inch?

In general: The flow of water through an opening with an area of 1 square inch under a head which varies in different localities from 4 to 6 inches. (The head is the vertical distance from the upstream water surface to the center of the opening, when the opening is free-flowing—see drawing on page 16.)

In northern California: The flow through an orifice with an area of 1 square inch under a head of 6 inches. This is the "statutory miner's inch"—the flow of 1½ cubic feet per minute (1/40 cu. ft. per sec. or approximately 11¼ g.p.m.)—in the California foothills, Arizona, Nevada, Oregon, and Montana.

In southern California: The flow through an orifice with an area of 1 square inch under a head of 4 inches (approximately 1/50 cu. ft. per sec. or 9 g.p.m.). This is the "statutory miner's inch" in Idaho, New Mexico, Utah, and Washington.

Others: In Colorado, 1/38.4 cu. ft. per sec.; in British Columbia, 1/35.7 cu. ft. per sec.

List of Equivalents

The following equivalents may be used for converting from one unit to another and for computing volumes from flow units:

Volume Units

One acre-inch
- = 3,630 cubic feet
- = 27,154 gallons
- = $\frac{1}{12}$ acre-foot

One acre-foot
- = 43,560 cubic feet
- = 325,851 gallons
- = 12 acre-inches

One cubic foot
- = 1,728 cubic inches
- = 7.481 (approximately 7.5) gallons
- weighs approximately 62.4 pounds (62.5 for ordinary calculations)

One gallon
- = 231 cubic inches
- = 0.13368 cubic foot
- weighs approximately 8.33 pounds

Rate of Flow Units

One cubic foot per second
- = 448.83 (approximately 450) gallons per minute
- = 50 Southern California miner's inches
- = 40 California statutory miner's inches
- = 1 acre-inch in 1 hour and 30 seconds (approximately 1 hour), or 0.992 (approximately 1) acre-inch per hour
- = 1 acre-foot in 12 hours and 6 minutes (approximately 12 hours), or 1.984 (approximately 2) acre-feet per day (24 hours)

One gallon per minute
- = 0.00223 (approximately $\frac{1}{450}$) cubic foot per second
- = 0.1114 (approximately $\frac{1}{9}$) Southern California miner's inch
- = 0.0891 (approximately $\frac{1}{11}$) California statutory miner's inch
- = 1 acre-inch in 452.6 (approximately 450) hours, or 0.00221 acre-inch per hour
- = 1 acre-foot in 226.3 days, or 0.00442 acre-foot per day
- = 1 inch depth of water over 96.3 square feet in 1 hour

Million gallons per day
- = 1.547 cubic feet per second
- = 694.4 gallons per minute
- = 77.36 Southern California miner's inches
- = 61.89 California statutory miner's inches

One Southern California miner's inch
- = 0.02 ($\frac{1}{50}$) cubic foot per second
- = 8.98 (approximately 9) gallons per minute
- = 0.80 ($\frac{4}{5}$) California statutory miner's inch
- = 1 acre-inch in 50 hours and 25 minutes, or 0.0198 (approximately $\frac{1}{50}$) acre-inch per hour
- = 1 acre-foot in 605 hours (approximately 25 days), or 0.0397 (approximately $\frac{1}{25}$) acre-foot per day

One California statutory miner's inch
- = 0.025 ($\frac{1}{40}$) cubic foot per second
- = 11.22 (approximately $11\frac{1}{4}$) gallons per minute
- = 1.25 Southern California miner's inches
- = 1 acre-inch in 40 hours and 20 minutes, or 0.0248 approximately $\frac{1}{40}$) acre-inch per hour
- = 1 acre-foot in 484 hours (approximately 20 days), or 0.0496 (approximately $\frac{1}{20}$) acre-foot per day

Conversion Table for Units of Flow

Units	Cubic feet per second	Gallons per minute	Million gallons per day	Southern Calif. miner's inches	Calif. statutory miner's inches	Acre-inches per 24 hours	Acre-feet per 24 hours
Cubic feet per second	1.0	448.8	0.646	50.0	40.0	23.80	1.984
Gallons per minute	0.00223	1.0	0.00144	0.1114	0.0891	0.053	0.00442
Million gallons per day	1.547	694.4	1.0	77.36	61.89	36.84	3.07
So. Calif. miner's inches	0.020	8.98	0.0129	1.0	0.80	0.476	0.0397
Calif. statutory miner's inches	0.025	11.22	0.0162	1.25	1.0	0.595	0.0496
Acre-inches per 24 hours	0.042	18.86	0.0271	2.10	1.68	1.0	0.0833
Acre-feet per 24 hours	0.504	226.3	0.3259	25.21	20.17	12.0	1.0

The following approximate formulas may be conveniently used to compute the depth of water applied to a field:

$$\frac{\text{Cu. ft. per sec.} \times \text{hours}}{\text{Acres}} = \text{acre-inches per acre, or average depth in inches.}$$

$$\frac{\text{Gal. per min.} \times \text{hours}}{450 \times \text{acres}} = \text{acre-inches per acre, or average depth in inches.}$$

$$\frac{\text{Southern California miner's inches} \times \text{hours}}{50 \times \text{acres}} = \text{acre-inches per acre, or average depth in inches.}$$

$$\frac{\text{California statutory miner's inches} \times \text{hours}}{40 \times \text{acres}} = \text{acre-inches per acre, or average depth in inches.}$$

Correction Factors for Submerged Flow

Size of flume W (feet)	Multiplying factor, M	Size of flume W (feet)	Multiplying factor, M
1	1.0	5	3.7
1.5	1.4	6	4.3
2	1.8	7	4.9
3	2.4	8	5.4
4	3.1	10	6.4

Tables

Table 1. Flow Rates for Slotted-Tube Flow Meter in 6, 8, and 10-inch Pipes with Slopes Up to .25 per cent*

Gage height (feet)	Discharge in gallons per minute for:		
	6″ Pipe (i.d.† = 5.874″)	8″ Pipe (i.d.† = 7.812″)	10″ Pipe (i.d.† = 10.0″)
0	0	0	0
.05	1.6	2.0	4
.10	7.4	8.0	13
.15	18.4	24.5	28
.20	36.0	40.0	50
.25	57.2	65.0	80
.30	81.4	94.5	117
.35	109.2	127	162
.40	139.2	166	212
.45	165.6	208	271
.50	192.0	252	332
.55	218.8	298	400
.60	....	346	470
.65	....	393	542
.70	....	438	616
.75	....	481	690
.80	....	...	764
.85	....	...	839
.90	....	...	912

* From University of Minnesota data.
† Inside diameter.

Table 2. Flow Rates for Slotted-Tube Flow Meter, Independent of Pipe Diameter with Slopes Up to .25 per cent*

H/D†	$\frac{Q‡}{D^{5/2}}$	H/D†	$\frac{Q‡}{D^{5/2}}$
0	.000	.60	1.04
.10	.020	.70	1.38
.20	.093	.80	1.75
.30	.247	.90	2.14
.40	.452	1.00	2.52
.50	.731	1.10	2.88

* From University of Minnesota data.
† Head (H) divided by Diameter (D).
‡ Flow in cu. ft. per sec. (Q) divided by Diameter to the five-half power ($D^{5/2}$).

Table 3. Flow Over Rectangular Contracted Weirs in Cubic Feet per Second*

Head in ft. "H"	Head in inches, approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
0.10	1 3/16	0.105	0.158	0.212	0.319	0.427	0.108
0.11	1 5/16	0.121	0.182	0.244	0.367	0.491	0.124
0.12	1 7/16	0.137	0.207	0.277	0.418	0.559	0.141
0.13	1 9/16	0.155	0.233	0.312	0.470	0.629	0.159
0.14	1 11/16	0.172	0.260	0.348	0.524	0.701	0.177
0.15	1 13/16	0.191	0.288	0.385	0.581	0.776	0.196
0.16	1 15/16	0.210	0.316	0.423	0.638	0.854	0.216
0.17	2 1/16	0.229	0.346	0.463	0.698	0.934	0.236
0.18	2 3/16	0.249	0.376	0.504	0.760	1.02	0.257
0.19	2 1/4	0.270	0.407	0.546	0.823	1.10	0.278
0.20	2 3/8	0.291	0.439	0.588	0.887	1.19	0.303
0.21	2 1/2	0.312	0.472	0.632	0.954	1.28	0.326
0.22	2 5/8	0.335	0.505	0.677	1.02	1.37	0.35
0.23	2 3/4	0.358	0.539	0.723	1.09	1.46	0.37
0.24	2 7/8	0.380	0.574	0.769	1.16	1.55	0.39
0.25	3	0.404	0.609	0.817	1.23	1.65	0.42
0.26	3 1/8	0.428	0.646	0.865	1.31	1.75	0.44
0.27	3 1/4	0.452	0.682	0.914	1.38	1.85	0.47
0.28	3 3/8	0.477	0.720	0.965	1.46	1.95	0.49
0.29	3 1/2	0.502	0.758	1.02	1.53	2.05	0.52
0.30	3 5/8	0.527	0.796	1.07	1.61	2.16	0.55
0.31	3 3/4	0.553	0.836	1.12	1.69	2.26	0.57
0.32	3 13/16	0.580	0.876	1.18	1.77	2.37	0.60
0.33	3 15/16	0.606	0.916	1.23	1.86	2.48	0.62
0.34	4 1/16	0.634	0.957	1.28	1.94	2.60	0.66
0.35	4 3/16	0.661	0.999	1.34	2.02	2.71	0.69
0.36	4 5/16	0.688	1.04	1.40	2.11	2.82	0.71
0.37	4 7/16	0.717	1.08	1.45	2.20	2.94	0.74
0.38	4 9/16	0.745	1.13	1.51	2.28	3.06	0.78
0.39	4 11/16	0.774	1.17	1.57	2.37	3.18	0.81
0.40	4 13/16	0.804	1.21	1.63	2.46	3.30	0.84
0.41	4 15/16	0.833	1.26	1.69	2.55	3.42	0.87
0.42	5 1/16	0.863	1.30	1.75	2.65	3.54	0.89
0.43	5 3/16	0.893	1.35	1.81	2.74	3.67	0.93
0.44	5 1/4	0.924	1.40	1.88	2.83	3.80	0.97

* Computed from Cone's formula: $Q = 3.247\ LH^{1.48} - \frac{0.566\ L^{1.8}}{1 + 2\ L^{1.8}}\ H^{1.9}$.

Table 3 (*Continued*). Flow Over Rectangular Contracted Weirs

Head in ft. "H"	Head in inches, approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
0.45	5 3/8	0.955	1.44	1.94	2.93	3.93	1.00
0.46	5 1/2	0.986	1.49	2.00	3.03	4.05	1.02
0.47	5 5/8	1.02	1.54	2.07	3.12	4.18	1.06
0.48	5 3/4	1.05	1.59	2.13	3.22	4.32	1.10
0.49	5 7/8	1.08	1.64	2.20	3.32	4.45	1.13
0.50	6	1.11	1.68	2.26	3.42	4.58	1.16
0.51	6 1/8	1.15	1.73	2.33	3.52	4.72	1.20
0.52	6 1/4	1.18	1.78	2.40	3.62	4.86	1.24
0.53	6 3/8	1.21	1.84	2.46	3.73	4.99	1.26
0.54	6 1/2	1.25	1.89	2.53	3.83	5.13	1.30
0.55	6 5/8	1.28	1.94	2.60	3.94	5.27	1.33
0.56	6 3/4	1.31	1.99	2.67	4.04	5.42	1.38
0.57	6 13/16	1.35	2.04	2.74	4.15	5.56	1.41
0.58	6 15/16	1.38	2.09	2.81	4.26	5.70	1.44
0.59	7 1/16	1.42	2.15	2.88	4.36	5.85	1.49
0.60	7 3/16	1.45	2.20	2.96	4.47	6.00	1.53
0.61	7 5/16	1.49	2.25	3.03	4.59	6.14	1.55
0.62	7 7/16	1.52	2.31	3.10	4.69	6.29	1.60
0.63	7 9/16	1.56	2.36	3.17	4.81	6.44	1.63
0.64	7 11/16	1.60	2.42	3.25	4.92	6.59	1.67
0.65	7 13/16	1.63	2.47	3.32	5.03	6.75	1.72
0.66	7 15/16	1.67	2.53	3.40	5.15	6.90	1.75
0.67	8 1/16	1.71	2.59	3.47	5.26	7.05	1.79
0.68	8 3/16	1.74	2.64	3.56	5.38	7.21	1.83
0.69	8 1/4	1.78	2.70	3.63	5.49	7.36	1.87
0.70	8 3/8	1.82	2.76	3.71	5.61	7.52	1.91
0.71	8 1/2	1.86	2.81	3.78	5.73	7.68	1.95
0.72	8 5/8	1.90	2.87	3.86	5.85	7.84	1.99
0.73	8 3/4	1.93	2.93	3.94	5.97	8.00	2.03
0.74	8 7/8	1.97	2.99	4.02	6.09	8.17	2.08
0.75	9	2.01	3.05	4.10	6.21	8.33	2.12
0.76	9 1/8	2.05	3.11	4.18	6.33	8.49	2.16
0.77	9 1/4	2.09	3.17	4.26	6.45	8.66	2.21
0.78	9 3/8	2.13	3.23	4.34	6.58	8.82	2.24
0.79	9 1/2	2.17	3.29	4.42	6.70	8.99	2.29

Table 3 (*Continued*). Flow Over Rectangular Contracted Weirs

Head in ft. "H"	Head in inches, approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
0.80	9 5/8	2.21	3.35	4.51	6.83	9.16	2.33
0.81	9 3/4	2.25	3.41	4.59	6.95	9.33	2.38
0.82	9 13/16	2.29	3.47	4.67	7.08	9.50	2.42
0.83	9 15/16	2.33	3.54	4.75	7.21	9.67	2.46
0.84	10 1/16	2.37	3.60	4.84	7.33	9.84	2.51
0.85	10 3/16	2.41	3.66	4.92	7.46	10.01	2.55
0.86	10 5/16	2.46	3.72	5.01	7.59	10.19	2.60
0.87	10 7/16	2.50	3.79	5.10	7.72	10.36	2.64
0.88	10 9/16	2.54	3.85	5.18	7.85	10.54	2.69
0.89	10 11/16	2.58	3.92	5.27	7.99	10.71	2.72
0.90	10 13/16	2.62	3.98	5.35	8.12	10.89	2.77
0.91	10 15/16	2.67	4.05	5.44	8.25	11.07	2.82
0.92	11 1/16	2.71	4.11	5.53	8.38	11.25	2.87
0.93	11 3/16	2.75	4.18	5.62	8.52	11.43	2.91
0.94	11 1/4	2.79	4.24	5.71	8.65	11.61	2.96
0.95	11 3/8	2.84	4.31	5.80	8.79	11.79	3.00
0.96	11 1/2	2.88	4.37	5.89	8.93	11.98	3.05
0.97	11 5/8	2.93	4.44	5.98	9.06	12.16	3.10
0.98	11 3/4	2.97	4.51	6.07	9.20	12.34	3.14
0.99	11 7/8	3.01	4.57	6.15	9.34	12.53	3.19
1.00	12	3.06	4.64	6.25	9.48	12.72	3.24
1.01	12 1/8	...	4.71	6.34	9.62	12.91	3.29
1.02	12 1/4	...	4.78	6.43	9.76	13.10	3.34
1.03	12 3/8	...	4.85	6.52	9.90	13.28	3.38
1.04	12 1/2	...	4.92	6.62	10.04	13.47	3.43
1.05	12 5/8	...	4.98	6.71	10.18	13.66	3.48
1.06	12 3/4	...	5.05	6.80	10.32	13.85	3.53
1.07	12 13/16	...	5.12	6.90	10.46	14.04	3.58
1.08	12 15/16	...	5.20	6.99	10.61	14.24	3.63
1.09	13 1/16	...	5.26	7.09	10.75	14.43	3.68
1.10	13 3/16	...	5.34	7.19	10.90	14.64	3.74
1.11	13 5/16	...	5.41	7.28	11.04	14.83	3.79
1.12	13 7/16	...	5.48	7.38	11.19	15.03	3.84
1.13	13 9/16	...	5.55	7.47	11.34	15.22	3.88
1.14	13 11/16	...	5.62	7.57	11.48	15.42	3.94

Table 3 (*Concluded*). Flow Over Rectangular Contracted Weirs

Head in ft. "H"	Head in inches, approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
1.15	13 13/16	...	5.69	7.66	11.64	15.62	3.98
1.16	13 15/16	...	5.77	7.76	11.79	15.82	4.03
1.17	14 1/16	...	5.84	7.86	11.94	16.02	4.08
1.18	14 3/16	...	5.91	7.96	12.09	16.23	4.14
1.19	14 1/4	...	5.98	8.06	12.24	16.43	4.19
1.20	14 3/8	...	6.06	8.16	12.39	16.63	4.24
1.21	14 1/2	...	6.13	8.26	12.54	16.83	4.29
1.22	14 5/8	...	6.20	8.35	12.69	17.03	4.34
1.23	14 3/4	...	6.28	8.46	12.85	17.25	4.40
1.24	14 7/8	...	6.35	8.56	12.99	17.45	4.46
1.25	15	...	6.43	8.66	13.14	17.65	4.51
1.26	15 1/8	...	...	...	13.30	17.87	4.57
1.27	15 1/4	...	...	...	13.45	18.07	4.62
1.28	15 5/8	...	...	...	13.61	18.28	4.67
1.29	15 1/2	...	...	...	13.77	18.50	4.73
1.30	15 5/8	...	...	...	13.93	18.71	4.78
1.31	15 3/4	...	...	...	14.09	18.92	4.82
1.32	15 13/16	...	...	...	14.24	19.12	4.88
1.33	15 15/16	...	...	...	14.40	19.34	4.94
1.34	16 1/16	...	...	...	14.56	19.55	4.99
1.35	16 3/16	...	...	...	14.72	19.77	5.05
1.36	16 5/16	...	...	...	14.88	19.98	5.10
1.37	16 7/16	...	...	...	15.04	20.20	5.16
1.38	16 9/16	...	...	...	15.20	20.42	5.22
1.39	16 11/16	...	...	...	15.36	20.64	5.28
1.40	16 13/16	...	...	...	15.53	20.86	5.33
1.41	16 15/16	...	...	...	15.69	21.08	5.39
1.42	17 1/16	...	...	...	15.85	21.29	5.44
1.43	17 3/16	...	...	...	16.02	21.52	5.50
1.44	17 1/4	...	...	...	16.19	21.74	5.55
1.45	17 3/8	...	...	...	16.34	21.96	5.62
1.46	17 1/2	...	...	...	16.51	22.18	5.67
1.47	17 5/8	...	...	...	16.68	22.41	5.73
1.48	17 3/4	...	...	...	16.85	22.64	5.79
1.49	17 7/8	...	...	...	17.01	22.85	5.84
1.50	18	...	...	...	17.17	23.08	5.91

Table 4. Flow Over 90° V Notch Weir in Cubic Feet per Second and Gallons per Minute*

Head in feet "H"	Head in inches approximately	Flow in cubic feet per second	Flow in gallons per minute
0.10	1 3/16	0.008	3.6
0.11	1 5/16	0.010	4.5
0.12	1 7/16	0.012	5.4
0.13	1 9/16	0.016	7.2
0.14	1 11/16	0.019	8.5
0.15	1 13/16	0.022	9.9
0.16	1 15/16	0.026	11.7
0.17	2 1/16	0.031	13.9
0.18	2 3/16	0.035	15.7
0.19	2 1/4	0.040	18.0
0.20	2 3/8	0.046	20.6
0.21	2 1/2	0.052	23.3
0.22	2 5/8	0.058	26.0
0.23	2 3/4	0.065	29.2
0.24	2 7/8	0.072	32.3
0.25	3	0.080	35.9
0.26	3 1/8	0.088	39.5
0.27	3 1/4	0.096	43.1
0.28	3 3/8	0.106	47.6
0.29	3 1/2	0.115	51.6
0.30	3 5/8	0.125	56.1
0.31	3 3/4	0.136	61.0
0.32	3 13/16	0.147	66.0
0.33	3 15/16	0.159	71.4
0.34	4 1/16	0.171	76.7
0.35	4 3/16	0.184	82.6
0.36	4 5/16	0.197	88.4
0.37	4 7/16	0.211	94.7
0.38	4 9/16	0.226	*101.0
0.39	4 11/16	0.240	108.0
0.40	4 13/16	0.256	115
0.41	4 15/16	0.272	122
0.42	5 1/16	0.289	130
0.43	5 3/16	0.306	137
0.44	5 1/4	0.324	145
0.45	5 3/8	0.343	154
0.46	5 1/2	0.362	162
0.47	5 5/8	0.382	171
0.48	5 3/4	0.403	181
0.49	5 7/8	0.424	190

* Computed from Cone's formulas: $Q = 2.49\ H^{2.48}$
$GPM = 448.8\ (2.49\ H^{2.48})$.

Table 4 (*Continued*). Flow over 90° V Notch Weir

Head in feet "H"	Head in inches approximately	Flow in cubic feet per second	Flow in gallons per minute
0.50	6	0.445	200
0.51	6 1/8	0.468	210
0.52	6 1/4	0.491	220
0.53	6 3/8	0.515	231
0.54	6 1/2	0.539	242
0.55	6 5/8	0.564	253
0.56	6 3/4	0.590	265
0.57	6 13/16	0.617	277
0.58	6 15/16	0.644	289
0.59	7 1/16	0.672	302
0.60	7 3/16	0.700	314
0.61	7 5/16	0.730	328
0.62	7 7/16	0.760	341
0.63	7 9/16	0.790	355
0.64	7 11/16	0.822	369
0.65	7 13/16	0.854	383
0.66	7 15/16	0.887	398
0.67	8 1/16	0.921	413
0.68	8 3/16	0.955	429
0.69	8 1/4	0.991	445
0.70	8 3/8	1.03	462
0.71	8 1/2	1.06	476
0.72	8 5/8	1.10	494
0.73	8 3/4	1.14	512
0.74	8 7/8	1.18	530
0.75	9	1.22	548
0.76	9 1/8	1.26	566
0.77	9 1/4	1.30	583
0.78	9 3/8	1.34	601
0.79	9 1/2	1.39	624
0.80	9 5/8	1.43	642
0.81	9 3/4	1.48	664
0.82	9 13/16	1.52	682
0.83	9 15/16	1.57	705
0.84	10 1/16	1.61	723
0.85	10 3/16	1.66	745
0.86	10 5/16	1.71	767
0.87	10 7/16	1.76	790
0.88	10 9/16	1.81	812
0.89	10 11/16	1.86	835

Table 4 (*Concluded*). Flow Over 90° V Notch Weir

Head in feet "H"	Head in inches approximately	Flow in cubic feet per second	Flow in gallons per minute
0.90	10 3/16	1.92	862
0.91	10 5/16	1.97	884
0.92	11 1/16	2.02	907
0.93	11 3/16	2.08	934
0.94	11 1/4	2.13	956
0.95	11 3/8	2.19	983
0.96	11 1/2	2.25	1,010
0.97	11 5/8	2.31	1,037
0.98	11 3/4	2.37	1,064
0.99	11 7/8	2.43	1,091
1.00	12	2.49	1,118
1.01	12 1/8	2.55	1,145
1.02	12 1/4	2.61	1,171
1.03	12 3/8	2.68	1,203
1.04	12 1/2	2.74	1,230
1.05	12 5/8	2.81	1,261
1.06	12 3/4	2.87	1,288
1.07	12 13/16	2.94	1,320
1.08	12 15/16	3.01	1,351
1.09	13 1/16	3.08	1,382
1.10	13 3/16	3.15	1,414
1.11	13 5/16	3.22	1,445
1.12	13 7/16	3.30	1,481
1.13	13 9/16	3.37	1,513
1.14	13 11/16	3.44	1,544
1.15	13 13/16	3.52	1,580
1.16	13 15/16	3.59	1,611
1.17	14 1/16	3.67	1,647
1.18	14 3/16	3.75	1,683
1.19	14 1/4	3.83	1,719
1.20	14 3/8	3.91	1,755
1.21	14 1/2	3.99	1,791
1.22	14 5/8	4.07	1,827
1.23	14 3/4	4.16	1,867
1.24	14 7/8	4.24	1,903
1.25	15	4.33	1,943

Table 5. Flow Over Cipolletti Weirs in Cubic Feet per Second*

Head in ft. "H"	Head in inches approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
0.10	1 3/16	0.107	0.160	0.214	0.321	0.429	0.108
0.11	1 5/16	0.123	0.185	0.246	0.370	0.494	0.124
0.12	1 7/16	0.140	0.210	0.280	0.421	0.562	0.141
0.13	1 9/16	0.158	0.237	0.316	0.474	0.632	0.159
0.14	1 11/16	0.177	0.264	0.352	0.528	0.706	0.177
0.15	1 13/16	0.195	0.293	0.390	0.586	0.782	0.196
0.16	1 15/16	0.216	0.322	0.430	0.644	0.860	0.216
0.17	2 1/16	0.237	0.353	0.470	0.705	0.941	0.236
0.18	2 3/16	0.258	0.384	0.512	0.768	1.024	0.257
0.19	2 1/4	0.280	0.417	0.555	0.832	1.110	0.278
0.20	2 3/8	0.302	0.450	0.599	0.898	1.20	0.302
0.21	2 1/2	0.324	0.484	0.644	0.966	1.29	0.324
0.22	2 5/8	0.349	0.519	0.691	1.04	1.38	0.35
0.23	2 3/4	0.374	0.555	0.739	1.11	1.47	0.37
0.24	2 7/8	0.397	0.591	0.786	1.18	1.57	0.39
0.25	3	0.423	0.628	0.836	1.25	1.67	0.42
0.26	3 1/8	0.449	0.667	0.886	1.33	1.77	0.44
0.27	3 1/4	0.475	0.705	0.937	1.40	1.87	0.47
0.28	3 3/8	0.502	0.745	0.990	1.48	1.97	0.49
0.29	3 1/2	0.529	0.785	1.04	1.56	2.08	0.52
0.30	3 5/8	0.557	0.827	1.10	1.64	2.19	0.55
0.31	3 3/4	0.586	0.869	1.15	1.73	2.30	0.57
0.32	3 13/16	0.615	0.911	1.21	1.81	2.41	0.60
0.33	3 15/16	0.644	0.954	1.27	1.89	2.52	0.62
0.34	4 1/16	0.675	1.00	1.32	1.98	2.64	0.66
0.35	4 3/16	0.705	1.04	1.38	2.07	2.75	0.69
0.36	4 5/16	0.735	1.09	1.44	2.16	2.87	0.71
0.37	4 7/16	0.767	1.13	1.50	2.25	2.99	0.74
0.38	4 9/16	0.799	1.18	1.57	2.34	3.11	0.78
0.39	4 11/16	0.832	1.23	1.63	2.43	3.24	0.81
0.40	4 13/16	0.866	1.28	1.69	2.53	3.36	0.84
0.41	4 15/16	0.899	1.32	1.76	2.62	3.49	0.87
0.42	5 1/16	0.932	1.37	1.82	2.72	3.61	0.89
0.43	5 3/16	0.967	1.42	1.89	2.81	3.74	0.93
0.44	5 1/4	1.00	1.47	1.95	2.91	3.87	0.97

* Computed from Cone's formula:

$$Q = 3.247\ LH^{1.48} - \frac{0.566\ L^{1.8}}{1 + 2\ L^{1.8}}\ H^{1.9} + 0.609\ H^{2.5}.$$

Table 5 (*Continued*). Flow Over Cipolletti Weirs

Head in ft. "H"	Head in inches approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
0.45	5 3/8	1.04	1.53	2.02	3.01	4.01	1.00
0.46	5 1/2	1.07	1.58	2.09	3.11	4.14	1.02
0.47	5 5/8	1.11	1.63	2.16	3.21	4.28	1.06
0.48	5 3/4	1.15	1.68	2.23	3.32	4.41	1.10
0.49	5 7/8	1.18	1.74	2.30	3.42	4.55	1.13
0.50	6	1.22	1.79	2.37	3.53	4.69	1.16
0.51	6 1/8	1.26	1.85	2.44	3.64	4.83	1.20
0.52	6 1/4	1.30	1.90	2.51	3.74	4.97	1.24
0.53	6 3/8	1.34	1.96	2.59	3.85	5.12	1.26
0.54	6 1/2	1.38	2.02	2.66	3.96	5.26	1.30
0.55	6 5/8	1.42	2.07	2.74	4.07	5.41	1.33
0.56	6 3/4	1.46	2.13	2.81	4.18	5.56	1.38
0.57	6 13/16	1.50	2.19	2.89	4.30	5.71	1.41
0.58	6 15/16	1.54	2.25	2.97	4.41	5.86	1.44
0.59	7 1/16	1.58	2.31	3.05	4.53	6.01	1.49
0.60	7 3/16	1.62	2.37	3.13	4.64	6.17	1.53
0.61	7 5/16	1.67	2.43	3.20	4.76	6.32	1.55
0.62	7 7/16	1.71	2.49	3.28	4.88	6.47	1.60
0.63	7 9/16	1.75	2.55	3.37	5.00	6.63	1.63
0.64	7 11/16	1.80	2.62	3.45	5.12	6.79	1.67
0.65	7 13/16	1.84	2.68	3.53	5.24	6.95	1.72
0.66	7 15/16	1.89	2.75	3.61	5.36	7.11	1.75
0.67	8 1/16	1.93	2.81	3.70	5.48	7.28	1.79
0.68	8 3/16	1.98	2.87	3.79	5.61	7.44	1.83
0.69	8 1/4	2.02	2.94	3.87	5.73	7.61	1.87
0.70	8 3/8	2.07	3.01	3.95	5.86	7.77	1.91
0.71	8 1/2	2.12	3.07	4.04	5.99	7.94	1.95
0.72	8 5/8	2.16	3.14	4.13	6.12	8.11	1.99
0.73	8 3/4	2.21	3.21	4.22	6.24	8.28	2.03
0.74	8 7/8	2.26	3.28	4.31	6.38	8.45	2.08
0.75	9	2.31	3.35	4.40	6.51	8.62	2.12
0.76	9 1/8	2.36	3.42	4.49	6.64	8.80	2.16
0.77	9 1/4	2.41	3.49	4.58	6.77	8.97	2.21
0.78	9 3/8	2.46	3.56	4.67	6.90	9.15	2.24
0.79	9 1/2	2.51	3.63	4.76	7.04	9.33	2.29

Table 5 (*Continued*). Flow Over Cipolletti Weirs

Head in ft. "H"	Head in inches approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
1.80	9 5/8	2.56	3.70	4.85	7.18	9.51	2.33
0.81	9 3/4	2.61	3.77	4.95	7 31	9.69	2.38
0.82	9 13/16	2.66	3.84	5.04	7.45	9.87	2.42
0.83	9 15/16	2.71	3.92	5.14	7.59	10.05	2.46
0.84	10 1/16	2.77	3.99	5.23	7.73	10.23	2.51
0.85	10 3/16	2.82	4.07	5.33	7.87	10.42	2.55
0.86	10 5/16	2.87	4.14	5.43	8.01	10.60	2.60
0.87	10 7/16	2.93	4.22	5.52	8.15	10.79	2.64
0.88	10 9/16	2.98	4.29	5.62	8.30	10.98	2.69
0.89	10 11/16	3.04	4.37	5.72	8.44	11.17	2.72
0.90	10 13/16	3.09	4.45	5.82	8.59	11.36	2.77
0.91	10 15/16	3.15	4.53	5.92	8.73	11.55	2.82
0.92	11 1/16	3.20	4.60	6.02	8.88	11.74	2.87
0.93	11 3/16	3.26	4.68	6.13	9.03	11.94	2.91
0.94	11 1/4	3.32	4.76	6.23	9.17	12.13	2.96
0.95	11 3/8	3.37	4.84	6.33	9.32	12.33	3.00
0.96	11 1/2	3.43	4.92	6.44	9.48	12.53	3.05
0.97	11 5/8	3.49	5.00	6.55	9.62	12.72	3.10
0.98	11 3/4	3.55	5.09	6.64	9.78	12.92	3.14
0.99	11 7/8	3.61	5.17	6.75	9.93	13.12	3.19
1.00	12	3.67	5.25	6.86	10.08	13.32	3.24
1.01	12 1/8	...	5.33	6.96	10.24	13.53	3.29
1.02	12 1/4	...	5.42	7.07	10.40	13.73	3.34
1.03	12 3/8	...	5.50	7.18	10.55	13.94	3.38
1.04	12 1/2	...	5.59	7.29	10.71	14.15	3.43
1.05	12 5/8	...	5.67	7.40	10.87	14.35	3.48
1.06	12 3/4	...	5.76	7.51	11.03	14.56	3.53
1.07	12 13/16	...	5.84	7.62	11.18	14.76	3.58
1.08	12 15/16	...	5.93	7.73	11.35	14.98	3.63
1.09	13 1/16	...	6.02	7.84	11.51	15.19	3.68
1.10	13 3/16	...	6.11	7.96	11.68	15.41	3.74
1.11	13 5/16	...	6.20	8.07	11.84	15.62	3.79
1.12	13 7/16	...	6.29	8.18	12.00	15.84	3.84
1.13	13 9/16	...	6.37	8.29	12.16	16.04	3.88
1.14	13 11/16	...	6.46	8.41	12.33	16.26	3.94

Table 5 (*Concluded*). Flow Over Cipolletti Weirs

Head in ft. "H"	Head in inches, approx.	Crest length (L)					For each additional foot of crest in excess of 4 ft. (approx.)
		1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet	
		Flow in cubic feet per second					
1.15	13 13/16	...	6.56	8.53	12.50	16.48	3.98
1.16	13 15/16	...	6.65	8.65	12.67	16.70	4.03
1.17	14 1/16	...	6.74	8.76	12.84	16.93	4.08
1.18	14 3/16	...	8.83	8.88	13.01	17.15	4.14
1.19	14 1/4	...	6.93	9.00	13.18	17.37	3.19
1.20	14 3/8	...	7.02	9.12	13.35	17.59	4.24
1.21	14 1/2	...	7.11	9.24	13.52	17.81	4.29
1.22	14 5/8	...	7.20	9.36	13.69	18.03	4.34
1.23	14 3/4	...	7.30	9.48	13.87	18.27	4.40
1.24	14 7/8	...	7.40	9.60	14.04	18.49	4.46
1.25	15	...	7.49	9.72	14.21	18.71	4.51
1.26	15 1/8	...	...	...	14.39	18.95	4.57
1.27	15 1/4	...	...	...	14.56	19.17	4.62
1.28	15 3/8	...	...	...	14.74	19.41	4.67
1.29	15 1/2	...	...	...	14.92	19.65	4.73
1.30	15 5/8	...	...	...	15.11	19.88	4.78
1.31	15 3/4	...	...	...	15.29	20.12	4.82
1.32	15 13/16	...	...	...	15.46	20.34	4.88
1.33	15 15/16	...	...	...	15.64	20.58	4.94
1.34	16 1/16	...	...	...	15.82	20.82	4.99
1.35	16 3/16	...	...	...	16.01	21.06	5.05
1.36	16 5/16	...	...	...	16.19	21.29	5.10
1.37	16 7/16	...	...	...	16.37	21.53	5.16
1.38	16 9/16	...	...	...	16.57	21.78	5.22
1.39	16 11/16	...	...	...	16.75	22.02	5.28
1.40	16 13/16	...	...	...	16.94	22.27	5.33
1.41	16 15/16	...	...	...	17.13	22.51	5.39
1.42	17 1/16	...	...	...	17.31	22.75	5.44
1.43	17 3/16	...	...	...	17.51	23.01	5.50
1.44	17 1/4	...	...	...	17.70	23.26	5.55
1.45	17 3/8	...	...	...	17.89	23.50	5.62
1.46	17 1/2	...	...	...	18.08	23.75	5.67
1.47	17 5/8	...	...	...	18.28	24.01	5.73
1.48	17 3/4	...	...	...	18.47	24.26	5.79
1.49	17 7/8	...	...	...	18.66	24.50	5.84
1.50	18	...	...	...	18.85	24.75	5.91

Table 6. Flow Over Rectangular Suppressed Weirs in Cubic Feet per Second*

Head, in feet	Head in inches, approx.	Weir height						
		0.5 foot	0.75 foot	1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet
		Flow in cubic feet per second per foot of weir crest						
0.10	1 3/16	0.111	0.110	0.109	0.109	0.108	0.108	0.108
0.11	1 5/16	0.127	0.126	0.126	0.125	0.125	0.125	0.124
0.12	1 7/16	0.145	0.144	0.143	0.142	0.142	0.141	0.141
0.13	1 9/16	0.163	0.162	0.161	0.160	0.159	0.159	0.159
0.14	1 11/16	0.182	0.180	0.179	0.178	0.178	0.177	0.177
0.15	1 13/16	0.202	0.200	0.199	0.197	0.197	0.196	0.196
0.16	1 15/16	0.223	0.220	0.219	0.217	0.216	0.216	0.215
0.17	2 1/16	0.244	0.241	0.239	0.238	0.237	0.236	0.235
0.18	2 3/16	0.266	0.263	0.261	0.259	0.257	0.257	0.256
0.19	2 1/4	0.289	0.285	0.283	0.280	0.279	0.277	0.277
0.20	2 3/8	0.312	0.307	0.305	0.302	0.300	0.299	0.299
0.21	2 1/2	0.336	0.331	0.328	0.325	0.324	0.322	0.322
0.22	2 5/8	0.361	0.355	0.352	0.349	0.347	0.345	0.344
0.23	2 3/4	0.387	0.386	0.376	0.372	0.370	0.369	0.368
0.24	2 7/8	0.413	0.406	0.401	0.397	0.395	0.393	0.392
0.25	3	0.440	0.431	0.427	0.422	0.420	0.418	0.416
0.26	3 1/8	0.467	0.458	0.452	0.447	0.445	0.442	0.442
0.27	3 1/4	0.495	0.485	0.479	0.473	0.471	0.468	0.467
0.28	3 3/8	0.524	0.513	0.506	0.500	0.498	0.495	0.493
0.29	3 1/2	0.554	0.541	0.535	0.527	0.524	0.521	0.520
0.30	3 5/8	0.583	0.569	0.562	0.555	0.552	0.548	0.545
0.31	3 11/16	0.614	0.599	0.591	0.583	0.580	0.576	0.574
0.32	3 13/16	0.645	0.629	0.620	0.612	0.608	0.604	0.602
0.33	3 15/16	0.677	0.659	0.650	0.641	0.637	0.633	0.631
0.34	4 1/16	0.709	0.690	0.681	0.670	0.666	0.662	0.660
0.35	4 3/16	0.742	0.722	0.711	0.701	0.696	0.691	0.688
0.36	4 5/16	0.775	0.754	0.743	0.731	0.725	0.721	0.717
0.37	4 7/16	0.810	0.787	0.774	0.762	0.757	0.751	0.748
0.38	4 9/16	0.844	0.819	0.807	0.793	0.788	0.782	0.778
0.39	4 11/16	0.881	0.853	0.840	0.826	0.819	0.813	0.809
0.40	4 13/16	0.916	0.888	0.873	0.858	0.851	0.844	0.840
0.41	4 15/16	0.952	0.922	0.907	0.890	0.883	0.876	0.872
0.42	5 1/16	0.990	0.958	0.942	0.924	0.917	0.908	0.904
0.43	5 1/8	1.03	0.994	0.976	0.958	0.950	0.941	0.937
0.44	5 1/4	1.07	1.03	1.01	0.993	0.983	0.974	0.969

* Computed from the simplified form of Rehbock's formula $Q = 2/3\, m\, L \sqrt{2g}\, h^{3/2}$, where $m = 0.605 + \frac{0.00328}{h} + 0.08\frac{h}{P}$ and P = height of weir crest above bottom of channel of approach.

Table 6 (*Continued*). Flow Over Rectangular Suppressed Weirs

Head, in feet	Head in inches, approx.	Weir height						
		0.5 foot	0.75 foot	1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet
		Flow in cubic feet per second per foot of weir crest						
0.45	5 3/8	1.10	1.07	1.05	1.03	1.02	1.01	1.00
0.46	5 1/2	1.14	1.10	1.08	1.06	1.05	1.04	1.04
0.47	5 5/8	1.18	1.14	1.12	1.10	1.09	1.08	1.07
0.48	5 3/4	1.22	1.18	1.16	1.13	1.12	1.11	1.10
0.49	5 7/8	1.27	1.22	1.19	1.17	1.16	1.15	1.14
0.50	6	1.31	1.26	1.23	1.21	1.20	1.18	1.18
0.51	6 1/8	1.35	1.30	1.27	1.24	1.23	1.22	1.21
0.52	6 1/4	1.39	1.34	1.31	1.28	1.27	1.25	1.25
0.53	6 3/8	1.44	1.38	1.35	1.32	1.30	1.29	1.28
0.54	6 1/2	1.48	1.42	1.39	1.36	1.34	1.33	1.32
0.55	6 5/8	1.52	1.46	1.43	1.40	1.38	1.36	1.36
0.56	6 11/16	1.57	1.50	1.47	1.44	1.42	1.40	1.39
0.57	6 13/16	1.61	1.54	1.51	1.48	1.46	1.44	1.43
0.58	6 15/16	1.66	1.59	1.55	1.52	1.50	1.48	1.47
0.59	7 1/16	1.71	1.63	1.60	1.56	1.54	1.52	1.51
0.60	7 3/16	1.76	1.68	1.64	1.60	1.58	1.56	1.55
0.61	7 5/16	1.80	1.72	1.68	1.64	1.62	1.59	1.58
0.62	7 7/16	1.85	1.77	1.72	1.68	1.66	1.63	1.62
0.63	7 9/16	1.90	1.81	1.77	1.72	1.70	1.68	1.67
0.64	7 11/16	1.95	1.86	1.81	1.76	1.74	1.72	1.71
0.65	7 13/16	2.00	1.90	1.86	1.81	1.78	1.76	1.75
0.66	7 15/16	2.05	1.95	1.90	1.85	1.82	1.80	1.79
0.67	8 1/16	2.10	2.00	1.95	1.90	1.87	1.84	1.83
0.68	8 1/8	2.15	2.05	1.99	1.94	1.91	1.88	1.87
0.69	8 1/4	2.21	2.09	2.04	1.98	1.95	1.93	1.91
0.70	8 3/8	2.26	2.14	2.08	2.03	2.00	1.97	1.95
0.71	8 1/2	2.31	2.19	2.13	2.07	2.04	2.01	2.00
0.72	8 5/8	2.37	2.24	2.18	2.12	2.08	2.05	2.04
0.73	8 3/4	2.42	2.29	2.23	2.16	2.13	2.10	2.08
0.74	8 7/8	2.48	2.34	2.28	2.21	2.18	2.14	2.12
0.75	9	2.53	2.39	2.32	2.25	2.22	2.18	2.17
0.76	9 1/8	2.59	2.45	2.37	2.30	2.27	2.23	2.21
0.77	9 1/4	2.65	2.50	2.43	2.35	2.31	2.27	2.26
0.78	9 3/8	2.70	2.55	2.48	2.40	2.36	2.32	2.30
0.79	9 1/2	2.76	2.60	2.52	2.45	2.41	2.37	2.35

Table 6 (*Continued*). Flow Over Rectangular Suppressed Weirs

Head, in feet	Head in inches, approx.	Weir height						
		0.5 foot	0.75 foot	1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet
		Flow in cubic feet per second per foot of weir crest						
0.80..	9 5/8	2.82	2.66	2.58	2.49	2.45	2.41	2.39
0.81..	9 11/16	2.88	2.71	2.63	2.54	2.50	2.46	2.44
0.82..	9 13/16	2.94	2.76	2.68	2.59	2.55	2.51	2.48
0.83..	9 15/16	3.00	2.82	2.73	2.64	2.60	2.55	2.53
0.84..	10 1/16	3.06	2.87	2.78	2.69	2.64	2.60	2.58
0.85..	10 3/16	3.12	2.93	2.84	2.74	2.69	2.65	2.62
0.86..	10 5/16	3.18	2.99	2.89	2.79	2.74	2.69	2.67
0.87..	10 7/16	3.25	3.04	2.94	2.84	2.80	2.74	2.72
0.88..	10 9/16	3.31	3.10	3.00	2.90	2.84	2.79	2.76
0.89..	10 11/16	3.37	3.16	3.05	2.95	2.89	2.84	2.81
0.90..	10 13/16	3.43	3.22	3.11	3.00	2.95	2.89	2.86
0.91..	10 15/16	3.50	3.27	3.16	3.05	2.99	2.94	2.91
0.92..	11 1/16	3.57	3.34	3.22	3.11	3.04	2.99	2.96
0.93..	11 3/16	3.63	3.40	3.28	3.16	3.10	3.04	3.01
0.94..	11 1/4	3.70	3.46	3.33	3.21	3.15	3.09	3.06
0.95..	11 3/8	3.76	3.52	3.39	3.26	3.20	3.14	3.11
0.96..	11 1/2	3.83	3.58	3.45	3.32	3.26	3.19	3.16
0.97..	11 5/8	3.90	3.64	3.51	3.37	3.31	3.24	3.21
0.98..	11 3/4	3.97	3.70	3.57	3.42	3.36	3.29	3.26
0.99..	11 7/8	4.04	3.76	3.62	3.48	3.41	3.35	3.31
1.00..	12	4.11	3.82	3.68	3.54	3.47	3.40	3.36
1.01..	12 1/8	...	3.89	3.74	3.59	3.52	3.45	3.41
1.02..	12 1/4	...	3.95	3.80	3.65	3.58	3.50	3.47
1.03..	12 3/8	...	4.01	3.86	3.71	3.63	3.56	3.52
1.04..	12 1/2	...	4.08	3.93	3.77	3.69	3.61	3.57
1.05..	12 5/8	...	4.14	3.98	3.82	3.74	3.66	3.62
1.06..	12 3/4	...	4.21	4.04	3.88	3.80	3.71	3.67
1.07..	12 13/16	...	4.27	4.11	3.94	3.85	3.77	3.73
1.08..	12 15/16	...	4.34	4.17	4.00	3.91	3.82	3.78
1.09..	13 1/16	...	4.41	4.24	4.05	3.97	3.88	3.83
1.10..	13 3/16	...	4.48	4.30	4.12	4.02	3.93	3.89
1.11..	13 5/16	...	4.54	4.36	4.17	4.09	3.99	3.94
1.12..	13 7/16	...	4.61	4.42	4.23	4.14	4.04	3.99
1.13..	13 9/16	...	4.68	4.49	4.29	4.19	4.10	4.05
1.14..	13 11/16	...	4.75	4.55	4.36	4.26	4.15	4.11

Table 6 (*Concluded*). Flow Over Rectangular Suppressed Weirs

Head, in feet	Head in inches, approx.	Weir height						
		0.5 foot	0.75 foot	1.0 foot	1.5 feet	2.0 feet	3.0 feet	4.0 feet
		Flow in cubic feet per second per foot of weir crest						
1.15	13 13/16	...	4.82	4.62	4.41	4.31	4.21	4.16
1.16	13 15/16	...	4.89	4.68	4.47	4.37	4.27	4.22
1.17	14 1/16	...	4.96	4.75	4.54	4.44	4.33	4.27
1.18	14 3/16	...	5.03	4.82	4.60	4.49	4.38	4.33
1.19	14 1/4	...	5.10	4.88	4.67	4.55	4.44	4.39
1.20	14 3/8	...	5.17	4.95	4.72	4.61	4.50	4.44
1.21	14 1/2	...	5.25	5.02	4.79	4.67	4.56	4.50
1.22	14 5/8	...	5.32	5.09	4.85	4.73	4.61	4.56
1.23	14 3/4	...	5.39	5.16	4.92	4.79	4.68	4.61
1.24	14 7/8	...	5.47	5.22	4.98	4.88	4.73	4.67
1.25	15	...	5.54	5.29	5.05	4.92	4.79	4.73
1.26	15 1/8	...	...	5.36	5.10	4.98	4.85	4.79
1.27	15 1/4	...	...	5.43	5.17	5.04	4.91	4.84
1.28	15 3/8	...	...	5.51	5.24	5.10	4.97	4.90
1.29	15 1/2	...	...	5.57	5.30	5.16	5.03	4.96
1.30	15 5/8	...	...	5.64	5.36	5.23	5.09	5.02
1.31	15 3/4	...	...	5.72	5.44	5.29	5.16	5.08
1.32	15 13/16	...	...	5.79	5.50	5.36	5.22	5.14
1.33	15 15/16	...	...	5.86	5.57	5.42	5.28	5.20
1.34	16 1/16	...	...	5.93	5.63	5.48	5.33	5.26
1.35	16 3/16	...	...	6.01	5.71	5.56	5.40	5.32
1.36	16 5/16	...	...	6.08	5.77	5.62	5.46	5.38
1.37	16 7/16	...	...	6.15	5.84	5.68	5.52	5.45
1.38	16 9/16	...	...	6.22	5.90	5.75	5.58	5.51
1.39	16 11/16	...	...	6.30	5.98	5.81	5.65	5.57
1.40	16 13/16	...	...	6.38	6.04	5.87	5.71	5.62
1.41	16 15/16	...	...	6.46	6.12	5.95	5.78	5.69
1.42	17 1/16	...	...	6.52	6.18	6.01	5.84	5.75
1.43	17 3/16	...	...	6.60	6.26	6.08	5.91	5.82
1.44	17 1/4	...	...	6.68	6.32	6.15	5.97	5.88
1.45	17 3/8	...	...	6.76	6.40	6.21	6.03	5.94
1.46	17 1/2	...	...	6.84	6.46	6.28	6.09	6.00
1.47	17 5/8	...	...	6.91	6.53	6.35	6.17	6.06
1.48	17 3/4	...	...	6.99	6.60	6.41	6.23	6.12
1.49	17 7/8	...	...	7.07	6.68	6.49	6.29	6.20
1.50	18	...	...	7.15	6.75	6.56	6.36	6.26

Table 7. Flow Through Orifices in Cubic Feet per Second*

Head, H, in feet	Head, in inches, approx.	Cross-sectional area of orifice, A						
		0.25 sq. ft.	0.333 sq. ft.	0.50 sq. ft.	0.75 sq. ft.	1.00 sq. ft.	1.50 sq. ft.	2.00 sq. ft.
		Flow in cubic feet per second						
0.01..	1/8	0.122	0.163	0.245	0.367	0.489	0.73	0.98
0.02..	1/4	0.173	0.230	0.346	0.518	0.691	1.04	1.38
0.03..	3/8	0.212	0.282	0.424	0.635	0.847	1.27	1.69
0.04..	1/2	0.245	0.326	0.489	0.734	0.978	1.47	1.96
0.05..	5/8	0.273	0.364	0.547	0.820	1.09	1.64	2.19
0.06..	3/4	0.300	0.399	0.599	0.899	1.20	1.80	2.40
0.07..	13/16	0.324	0.431	0.647	0.971	1.29	1.94	2.59
0.08..	15/16	0.346	0.461	0.691	1.04	1.38	2.07	2.77
0.09..	1 1/16	0.367	0.489	0.734	1.10	1.47	2.20	2.94
0.10..	1 3/16	0.387	0.518	0.773	1.16	1.56	2.32	3.09
0.11..	1 5/16	0.406	0.540	0.811	1.22	1.62	2.43	3.24
0.12..	1 7/16	0.424	0.564	0.847	1.27	1.69	2.54	3.39
0.13..	1 9/16	0.441	0.587	0.882	1.32	1.76	2.65	3.53
0.14..	1 11/16	0.458	0.609	0.915	1.37	1.83	2.75	3.66
0.15..	1 13/16	0.474	0.631	0.947	1.42	1.90	2.84	3.79
0.16..	1 15/16	0.489	0.651	0.978	1.47	1.96	2.93	3.91
0.17..	2 1/16	0.504	0.671	1.01	1.51	2.02	3.02	4.03
0.18..	2 3/16	0.519	0.691	1.04	1.56	2.08	3.11	4.15
0.19..	2 1/4	0.533	0.710	1.07	1.60	2.13	3.20	4.26
0.20..	2 3/8	0.547	0.729	1.09	1.64	2.19	3.28	4.38
0.21..	2 1/2	0.561	0.746	1.12	1.68	2.24	3.36	4.48
0.22..	2 5/8	0.574	0.765	1.15	1.72	2.30	3.46	4.59
0.23..	2 3/4	0.587	0.781	1.17	1.76	2.35	3.52	4.69
0.24..	2 7/8	0.600	0.798	1.20	1.80	2.40	3.60	4.79
0.25..	3	0.612	0.815	1.22	1.83	2.45	3.67	4.89
0.26..	3 1/8	0.624	0.831	1.25	1.87	2.49	3.74	4.99
0.27..	3 1/4	0.636	0.846	1.27	1.91	2.54	3.81	5.08
0.28..	3 3/8	0.646	0.862	1.29	1.94	2.59	3.88	5.18
0.29..	3 1/2	0.659	0.878	1.32	1.98	2.64	3.96	5.28
0.30..	3 5/8	0.670	0.892	1.34	2.01	2.68	4.02	5.36
0.31..	3 3/4	0.681	0.908	1.36	2.05	2.73	4.09	5.45
0.32..	3 13/16	0.692	0.920	1.38	2.07	2.76	4.15	5.53
0.33..	3 15/16	0.703	0.936	1.41	2.11	2.81	4.22	5.62
0.34..	4 1/16	0.713	0.950	1.43	2.14	2.85	4.28	5.70
0.35..	4 3/16	0.724	0.963	1.45	2.17	2.89	4.34	5.78
0.36..	4 5/16	0.734	0.976	1.47	2.20	2.93	4.40	5.87
0.37..	4 7/16	0.745	0.991	1.49	2.23	2.98	4.46	5.95
0.38..	4 9/16	0.754	1.00	1.51	2.26	3.02	4.52	6.03
0.39..	4 11/16	0.764	1.02	1.53	2.29	3.05	4.58	6.11
0.40..	4 13/16	0.774	1.03	1.55	2.32	3.09	4.64	6.19

* Computed from the formula $Q = 0.61\ A\ \sqrt{2\ g\ H}$.

Table 7 (*Continued*). Flow Through Orifices

Head, H, in feet	Head, in inches, approx.	Cross-sectional area of orifice, A						
		0.25 sq. ft.	0.333 sq. ft.	0.50 sq. ft.	0.75 sq. ft.	1.00 sq. ft.	1.50 sq. ft.	2.00 sq. ft.
		Flow in cubic feet per second						
0.41	4 15/16	0.783	1.04	1.57	2.35	3.13	4.70	6.27
0.42	5 1/16	0.792	1.06	1.59	2.38	3.17	4.75	6.34
0.43	5 3/16	0.802	1.07	1.60	2.41	3.21	4.81	6.42
0.44	5 1/4	0.811	1.08	1.62	2.43	3.24	4.87	6.49
0.45	5 3/8	0.820	1.09	1.64	2.46	3.28	4.92	6.56
0.46	5 1/2	0.829	1.10	1.66	2.49	3.32	4.98	6.64
0.47	5 5/8	0.839	1.12	1.68	2.52	3.36	5.04	6.71
0.48	5 3/4	0.847	1.13	1.70	2.54	3.39	5.08	6.78
0.49	5 7/8	0.856	1.14	1.71	2.57	3.42	5.14	6.85
0.50	6	0.865	1.15	1.73	2.59	3.46	5.19	6.92
0.51	6 1/8	0.873	1.16	1.75	2.62	3.49	5.24	6.99
0.52	6 1/4	0.882	1.17	1.76	2.65	3.53	5.29	7.05
0.53	6 3/8	0.890	1.19	1.78	2.67	3.56	5.34	7.12
0.54	6 1/2	0.898	1.20	1.80	2.70	3.59	5.39	7.19
0.55	6 5/8	0.907	1.21	1.81	2.72	3.63	5.44	7.25
0.56	6 3/4	0.915	1.22	1.83	2.75	3.66	5.49	7.32
0.57	6 13/16	0.923	1.23	1.85	2.77	3.69	5.54	7.38
0.58	6 15/16	0.931	1.24	1.86	2.79	3.73	5.59	7.45
0.59	7 1/16	0.939	1.25	1.88	2.82	3.76	5.64	7.51
0.60	7 3/16	0.947	1.26	1.90	2.84	3.79	5.68	7.58
0.61	7 5/16	0.955	1.27	1.91	2.87	3.82	5.73	7.64
0.62	7 7/16	0.963	1.28	1.93	2.89	3.85	5.78	7.70
0.63	7 9/16	0.971	1.29	1.94	2.91	3.88	5.82	7.76
0.64	7 11/16	0.978	1.30	1.96	2.93	3.91	5.87	7.82
0.65	7 13/16	0.986	1.31	1.97	2.96	3.94	5.92	7.89
0.66	7 15/16	0.993	1.32	1.99	2.98	3.97	5.96	7.95
0.67	8 1/16	1.00	1.33	2.00	3.00	4.00	6.01	8.01
0.68	8 3/16	1.01	1.34	2.02	3.02	4.03	6.05	8.06
0.69	8 1/4	1.02	1.35	2.03	3.05	4.06	6.10	8.13
0.70	8 3/8	1.02	1.36	2.05	3.07	4.09	6.14	8.18
0.71	8 1/2	1.03	1.37	2.06	3.09	4.12	6.19	8.25
0.72	8 5/8	1.04	1.38	2.08	3.11	4.15	6.23	8.30
0.73	8 3/4	1.05	1.39	2.09	3.14	4.18	6.27	8.36
0.74	8 7/8	1.05	1.40	2.10	3.16	4.21	6.31	8.42
0.75	9	1.06	1.41	2.12	3.18	4.24	6.36	8.48
0.76	9 1/8	1.07	1.42	2.13	3.20	4.26	6.40	8.53
0.77	9 1/4	1.07	1.43	2.15	3.22	4.29	6.43	8.58
0.78	9 3/8	1.08	1.44	2.16	3.24	4.32	6.48	8.64
0.79	9 1/2	1.09	1.45	2.17	3.26	4.35	6.52	8.70
0.80	9 5/8	1.09	1.46	2.19	3.28	4.38	6.56	8.75

Table 8

Table 8. Free Flow Through Parshall Measuring Flumes in Cubic Feet per Second

Head		Throat width											
Feet	Inches (approx.)	3″	6″	9″	1′	1.5′	2′	3′	4′	5′	6′	7′	8′	10′
		Flow in cubic feet per second												
0.10	1 3/16	0.028	0.05	0.09	0.11	0.15								
0.11	1 5/16	0.033	0.06	0.10	0.12	0.18								
0.12	1 7/16	0.037	0.07	0.12	0.14	0.20								
0.13	1 9/16	0.042	0.08	0.14	0.16	0.24								
0.14	1 11/16	0.047	0.09	0.15	0.18	0.27								
0.15	1 13/16	0.053	0.10	0.17	0.20	0.30								
0.16	1 15/16	0.058	0.11	0.19	0.23	0.34								
0.17	2 1/16	0.064	0.12	0.20	0.26	0.38								
0.18	2 3/16	0.070	0.14	0.22	0.29	0.42								
0.19	2 1/4	0.076	0.15	0.24	0.32	0.46								
0.20	2 3/8	0.082	0.16	0.26	0.35	0.50	0.66	0.97	1.26					
0.21	2 1/2	0.089	0.18	0.28	0.37	0.54	0.71	1.04	1.36					
0.22	2 5/8	0.095	0.19	0.30	0.40	0.58	0.77	1.12	1.47					
0.23	2 3/4	0.102	0.20	0.32	0.43	0.63	0.82	1.20	1.58					
0.24	2 7/8	0.109	0.22	0.35	0.46	0.67	0.88	1.28	1.69					
0.25	3	0.117	0.23	0.37	0.49	0.71	0.93	1.37	1.80	2.22	2.63			
0.26	3 1/8	0.124	0.25	0.39	0.51	0.76	0.99	1.46	1.91	2.36	2.80			
0.27	3 1/4	0.131	0.26	0.41	0.54	0.80	1.05	1.55	2.03	2.50	2.97			
0.28	3 3/8	0.138	0.28	0.44	0.58	0.85	1.11	1.64	2.15	2.65	3.15			
0.29	3 1/2	0.146	0.29	0.46	0.61	0.90	1.18	1.73	2.27	2.80	3.33			
0.30	3 5/8	0.154	0.31	0.49	0.64	0.94	1.24	1.82	2.39	2.96	3.52	4.08	4.62	
0.31	3 3/4	0.162	0.32	0.51	0.68	0.99	1.30	1.92	2.52	3.12	3.71	4.30	4.88	
0.32	3 13/16	0.170	0.34	0.54	0.71	1.04	1.37	2.02	2.65	3.28	3.90	4.52	5.13	
0.33	3 15/16	0.179	0.36	0.56	0.74	1.09	1.44	2.12	2.78	3.44	4.10	4.75	5.39	
0.34	4 1/16	0.187	0.38	0.59	0.77	1.14	1.50	2.22	2.92	3.61	4.30	4.98	5.66	
0.35	4 3/16	0.196	0.39	0.62	0.80	1.19	1.57	2.32	3.06	3.78	4.50	5.22	5.93	
0.36	4 5/16	0.205	0.41	0.64	0.84	1.25	1.64	2.42	3.19	3.95	4.71	5.46	6.20	

	$1\frac{1}{16}$	0.213	0.43	0.67	0.88	1.30	1.72	2.53	3.34	4.13	4.92	5.70	6.48	
0.38	$4\frac{9}{16}$	0.222	0.45	0.70	0.92	1.36	1.79	2.64	3.48	4.31	5.13	5.95	6.76	
0.39	$4\frac{11}{16}$	0.231	0.47	0.73	0.95	1.41	1.86	2.75	3.62	4.49	5.35	6.20	7.05	
0.40	$4\frac{13}{16}$	0.241	0.48	0.76	0.99	1.47	1.93	2.86	3.77	4.68	5.57	6.46	7.34	9.1
0.41	$4\frac{15}{16}$	0.250	0.50	0.78	1.03	1.53	2.01	2.97	3.92	4.86	5.80	6.72	7.64	9.5
0.42	$5\frac{1}{16}$	0.260	0.52	0.81	1.07	1.58	2.09	3.08	4.07	5.05	6.02	6.98	7.94	9.8
0.43	$5\frac{3}{16}$	0.269	0.54	0.84	1.11	1.64	2.16	3.20	4.22	5.24	6.25	7.25	8.24	10.2
0.44	$5\frac{1}{4}$	0.279	0.56	0.87	1.15	1.70	2.24	3.32	4.38	5.43	6.48	7.52	8.55	10.6
0.45	$5\frac{3}{8}$	0.289	0.58	0.90	1.19	1.76	2.32	3.44	4.54	5.63	6.72	7.80	8.87	11.0
0.46	$5\frac{1}{2}$	0.299	0.61	0.94	1.23	1.82	2.40	3.56	4.70	5.83	6.96	8.08	9.19	11.4
0.47	$5\frac{5}{8}$	0.309	0.63	0.97	1.27	1.88	2.48	3.68	4.86	6.03	7.20	8.36	9.51	11.8
0.48	$5\frac{3}{4}$	0.319	0.65	1.00	1.31	1.94	2.57	3.80	5.03	6.24	7.44	8.65	9.8	12.2
0.49	$5\frac{7}{8}$	0.329	0.67	1.03	1.35	2.00	2.65	3.92	5.20	6.45	7.69	8.94	10.2	12.6
0.50	6	0.339	0.69	1.06	1.39	2.06	2.73	4.05	5.36	6.66	7.94	9.23	10.5	13.1
0.51	$6\frac{1}{8}$	0.350	0.71	1.10	1.44	2.13	2.82	4.18	5.53	6.87	8.20	9.53	10.9	13.5
0.52	$6\frac{1}{4}$	0.361	0.73	1.13	1.48	2.19	2.90	4.31	5.70	7.09	8.46	9.83	11.2	13.9
0.53	$6\frac{3}{8}$	0.371	0.76	1.16	1.52	2.25	2.99	4.44	5.88	7.30	8.72	10.1	11.5	14.3
0.54	$6\frac{1}{2}$	0.382	0.78	1.20	1.57	2.32	3.08	4.57	6.05	7.52	8.98	10.5	11.9	14.8
0.55	$6\frac{5}{8}$	0.393	0.80	1.23	1.62	2.39	3.17	4.70	6.23	7.74	9.25	10.8	12.2	15.2
0.56	$6\frac{3}{4}$	0.404	0.82	1.26	1.66	2.45	3.26	4.84	6.41	7.97	9.52	11.1	12.6	15.7
0.57	$6\frac{13}{16}$	0.415	0.85	1.30	1.70	2.52	3.35	4.98	6.59	8.20	9.79	11.4	13.0	16.1
0.58	$6\frac{15}{16}$	0.427	0.87	1.33	1.75	2.59	3.44	5.11	6.77	8.43	10.1	11.7	13.3	16.6
0.59	$7\frac{1}{16}$	0.438	0.89	1.37	1.80	2.66	3.53	5.25	6.96	8.66	10.4	12.0	13.7	17.1
0.60	$7\frac{3}{16}$	0.450	0.92	1.40	1.84	2.73	3.62	5.39	7.15	8.89	10.6	12.4	14.1	17.5
0.61	$7\frac{5}{16}$	0.462	0.94	1.44	1.88	2.80	3.72	5.53	7.34	9.13	10.9	12.7	14.5	18.0
0.62	$7\frac{7}{16}$	0.474	0.97	1.48	1.93	2.87	3.81	5.68	7.53	9.37	11.2	13.0	14.8	18.5
0.63	$7\frac{9}{16}$	0.485	0.99	1.51	1.98	2.95	3.91	5.82	7.72	9.61	11.5	13.4	15.2	19.0
0.64	$7\frac{11}{16}$	0.497	1.02	1.55	2.03	3.02	4.01	5.97	7.91	9.85	11.8	13.7	15.6	19.5
0.65	$7\frac{13}{16}$	0.509	1.04	1.59	2.08	3.09	4.11	6.12	8.11	10.1	12.1	14.1	16.0	19.9
0.66	$7\frac{15}{16}$	0.522	1.07	1.63	2.13	3.17	4.20	6.26	8.31	10.3	12.4	14.4	16.4	20.4
0.67	$8\frac{1}{16}$	0.534	1.10	1.66	2.18	3.24	4.30	6.41	8.51	10.6	12.7	14.8	16.8	20.9
0.68	$8\frac{3}{16}$	0.546	1.12	1.70	2.23	3.31	4.40	6.56	8.71	10.9	13.0	15.1	17.2	21.5
0.69	$8\frac{1}{4}$	0.558	1.15	1.74	2.28	3.39	4.50	6.71	8.91	11.1	13.3	15.5	17.6	22.0

Table 8 (*Continued*). Free Flow Through Parshall Measuring Flumes

Head		Throat width												
Feet	Inches (approx.)	3″	6″	9″	1′	1.5′	2′	3′	4′	5′	6′	7′	8′	10′
		Flow in cubic feet per second												
0.70	8 3/8	0.571	1.17	1.78	2.33	3.46	4.60	6.86	9.11	11.4	13.6	15.8	18.0	22.5
0.71	8 1/2	0.584	1.20	1.82	2.38	3.54	4.70	7.02	9.32	11.6	13.9	16.2	18.5	23.0
0.72	8 5/8	0.597	1.23	1.86	2.43	3.62	4.81	7.17	9.53	11.9	14.2	16.6	18.9	23.5
0.73	8 3/4	0.610	1.26	1.90	2.48	3.69	4.91	7.33	9.74	12.1	14.5	16.9	19.3	24.1
0.74	8 7/8	0.623	1.28	1.94	2.53	3.77	5.02	7.49	9.95	12.4	14.9	17.3	19.7	24.6
0.75	9	....	1.31	1.98	2.58	3.85	5.12	7.65	10.2	12.7	15.2	17.7	20.1	25.1
0.76	9 1/8	....	1.34	2.02	2.63	3.93	5.23	7.81	10.4	12.9	15.5	18.0	20.6	25.7
0.77	9 1/4	....	1.36	2.06	2.68	4.01	5.34	7.97	10.6	13.2	15.8	18.4	21.0	26.2
0.78	9 3/8	....	1.39	2.10	2.74	4.09	5.44	8.13	10.8	13.5	16.2	18.8	21.5	26.8
0.79	9 1/2	....	1.42	2.14	2.80	4.17	5.55	8.30	11.0	13.8	16.5	19.2	21.9	27.3
0.80	9 5/8	....	1.45	2.18	2.85	4.26	5.66	8.46	11.3	14.0	16.8	19.6	22.4	27.9
0.81	9 3/4	....	1.48	2.22	2.90	4.34	5.77	8.63	11.5	14.3	17.2	20.0	22.8	28.5
0.82	9 13/16	....	1.50	2.27	2.96	4.42	5.88	8.79	11.7	14.6	17.5	20.4	23.3	29.0
0.83	9 15/16	....	1.53	2.31	3.02	4.50	6.00	8.96	11.9	14.9	17.8	20.8	23.7	29.6
0.84	10 1/16	....	1.56	2.35	3.07	4.59	6.11	9.13	12.2	15.2	18.2	21.2	24.2	30.2
0.85	10 3/16	....	1.59	2.39	3.12	4.69	6.22	9.30	12.4	15.5	18.5	21.6	24.6	30.8
0.86	10 5/16	....	1.62	2.44	3.18	4.76	6.33	9.48	12.6	15.8	18.9	22.0	25.1	31.4
0.87	10 7/16	....	1.65	2.48	3.24	4.84	6.44	9.65	12.8	16.0	19.2	22.4	25.6	31.9
0.88	10 9/16	....	1.68	2.52	3.29	4.93	6.56	9.82	13.1	16.3	19.6	22.8	26.1	32.5
0.89	10 11/16	....	1.71	2.57	3.35	5.01	6.68	10.0	13.3	16.6	19.9	23.2	26.5	33.1
0.90	10 13/16	....	1.74	2.61	3.41	5.10	6.80	10.2	13.6	16.9	20.3	23.7	27.0	33.7
0.91	10 15/16	....	1.77	2.66	3.46	5.19	6.92	10.4	13.8	17.2	20.7	24.1	27.5	34.4
0.92	11 1/16	....	1.81	2.70	3.52	5.28	7.03	10.5	14.0	17.5	21.0	24.5	28.0	35.0
0.93	11 3/16	....	1.84	2.75	3.58	5.37	7.15	10.7	14.3	17.8	21.4	24.9	28.5	35.6
0.94	11 1/4	....	1.87	2.79	3.64	5.46	7.27	10.9	14.5	18.1	21.8	25.4	29.0	36.2
0.95	11 3/8	....	1.90	2.84	3.70	5.55	7.39	11.1	14.8	18.4	22.1	25.8	29.5	36.8
0.96	11 1/2	....	1.93	2.88	3.76	5.64	7.51	11.3	15.0	18.8	22.5	26.2	30.0	37.5

0.98	11¾	....	2.00	2.98	3.88	5.82	7.75	11.6	15.5	19.4	23.2	27.1	31.0	38.7
0.99	11⅞	....	2.03	3.02	3.94	5.91	7.88	11.8	15.8	19.7	23.6	27.6	31.5	39.4
1.00	12	....	2.06	3.07	4.00	6.00	8.00	12.0	16.0	20.0	24.0	28.0	32.0	40.0
1.01	12⅛	....	2.09	3.12	4.06	6.09	8.12	12.2	16.3	20.3	24.4	28.4	32.5	40.7
1.02	12¼	....	2.12	3.17	4.12	6.19	8.25	12.4	16.5	20.6	24.8	28.9	33.0	41.3
1.03	12⅜	....	2.16	3.21	4.18	6.28	8.38	12.6	16.8	21.0	25.2	29.4	33.6	42.0
1.04	12½	....	2.19	3.26	4.25	6.37	8.50	12.8	17.0	21.3	25.6	29.8	34.1	42.6
1.05	12⅝	....	2.22	3.31	4.31	6.47	8.63	13.0	17.3	21.6	25.9	30.3	34.6	43.3
1.06	12¾	....	2.26	3.36	4.37	6.56	8.76	13.2	17.5	21.9	26.3	30.7	35.1	44.0
1.07	12 13/16	....	2.29	3.40	4.43	6.66	8.88	13.3	17.8	22.3	26.7	31.2	35.7	44.6
1.08	12 15/16	....	2.32	3.45	4.50	6.75	9.01	13.5	18.1	22.6	27.1	31.7	36.2	45.3
1.09	13 1/16	....	2.36	3.50	4.56	6.85	9.14	13.7	18.3	22.9	27.5	32.1	36.8	46.0
1.10	13 3/16	....	2.40	3.55	4.62	6.95	9.27	13.9	18.6	23.3	27.9	32.6	37.3	46.7
1.11	13 5/16	....	2.43	3.60	4.68	7.04	9.40	14.1	18.9	23.6	28.4	33.1	37.8	47.4
1.12	13 7/16	....	2.46	3.65	4.75	7.14	9.54	14.3	19.1	23.9	28.8	33.6	38.4	48.0
1.13	13 9/16	....	2.50	3.70	4.82	7.24	9.67	14.5	19.4	24.3	29.2	34.1	38.9	48.7
1.14	13 11/16	....	2.53	3.75	4.88	7.34	9.80	14.7	19.7	24.6	29.6	34.5	39.5	49.4
1.15	13 1/16	....	2.57	3.80	4.94	7.44	9.94	14.9	19.9	25.0	30.0	35.0	40.1	50.1
1.16	13 15/16	....	2.60	3.85	5.01	7.54	10.1	15.1	20.2	25.3	30.4	35.5	40.6	50.8
1.17	14 1/16	....	2.64	3.90	5.08	7.64	10.2	15.3	20.5	25.7	30.8	36.0	41.2	51.6
1.18	14 3/16	....	2.68	3.95	5.15	7.74	10.3	15.6	20.8	26.0	31.3	36.5	41.8	52.3
1.19	14¼	....	2.71	4.01	5.21	7.84	10.5	15.8	21.1	26.4	31.7	37.0	42.3	53.0
1.20	14⅜	....	2.75	4.06	5.28	7.94	10.6	16.0	21.3	26.7	32.1	37.5	42.9	53.7
1.21	14½	....	2.78	4.11	5.34	8.05	10.8	16.2	21.6	27.1	32.5	38.0	43.5	54.4
1.22	14⅝	....	2.82	4.16	5.41	8.15	10.9	16.4	21.9	27.4	33.0	38.5	44.1	55.2
1.23	14¾	....	2.86	4.22	5.48	8.25	11.0	16.6	22.2	27.8	33.4	39.0	44.6	55.9
1.24	14⅞	....	2.89	4.27	5.55	8.36	11.2	16.8	22.5	28.1	33.8	39.5	45.2	56.6
1.25	15	....	...	4.32	5.62	8.46	11.3	17.0	22.8	28.5	34.3	40.0	45.8	57.4
1.26	15⅛	....	...	4.37	5.69	8.56	11.5	17.2	23.0	28.9	34.7	40.5	46.4	58.1
1.27	15¼	....	...	4.43	5.76	8.67	11.6	17.4	23.3	29.2	35.1	41.1	47.0	58.9
1.28	15⅜	....	...	4.48	5.82	8.77	11.7	17.7	23.6	29.6	35.6	41.6	47.6	59.6
1.29	15½	....	...	4.53	5.89	8.88	11.9	17.9	23.9	30.0	36.0	42.1	48.2	60.4

Table 8 (*Continued*). Free Flow Through Parshall Measuring Flumes

Head		Throat width												
Feet	Inches (approx.)	3″	6″	9″	1′	1.5′	2′	3′	4′	5′	6′	7′	8′	10′
		Flow in cubic feet per second												
1.30	15 5/8	....	...	4.59	5.96	8.99	12.0	18.1	24.2	30.3	36.5	42.6	48.8	61.1
1.31	15 3/4	....	...	4.64	6.03	9.09	12.2	18.3	24.5	30.7	36.9	43.1	49.4	61.9
1.32	15 13/16	....	...	4.69	6.10	9.20	12.3	18.5	24.8	31.1	37.4	43.7	50.0	62.7
1.33	15 15/16	....	...	4.75	6.18	9.30	12.4	18.8	25.1	31.4	37.8	44.2	50.6	63.4
1.34	16 1/16	....	...	4.80	6.25	9.41	12.6	19.0	25.4	31.8	38.3	44.7	51.2	64.2
1.35	16 3/16	....	...	4.86	6.32	9.52	12.7	19.2	25.7	32.2	38.7	45.3	51.8	65.0
1.36	16 5/16	....	...	4.92	6.39	9.63	12.9	19.4	26.0	32.6	39.2	45.8	52.5	65.7
1.37	16 7/16	....	...	4.97	6.46	9.74	13.0	19.6	26.3	33.0	39.7	46.4	53.1	66.5
1.38	16 9/16	....	...	5.03	6.53	9.85	13.2	19.9	26.6	33.3	40.1	46.9	53.7	67.3
1.39	16 11/16	....	...	5.08	6.60	9.96	13.3	20.1	26.9	33.7	40.6	47.4	54.3	68.1
1.40	16 13/16	....	...	...	6.68	10.1	13.5	20.3	27.2	34.1	41.1	48.0	55.0	68.9
1.41	16 15/16	....	...	...	6.75	10.2	13.6	20.6	27.5	34.5	41.5	48.5	55.6	69.7
1.42	17 1/16	....	...	...	6.82	10.3	13.8	20.8	27.8	34.9	42.0	49.1	56.2	70.5
1.43	17 3/16	....	...	...	6.89	10.4	13.9	21.0	28.1	35.3	42.5	49.6	56.9	71.3
1.44	17 1/4	....	...	...	6.97	10.5	14.1	21.2	28.5	35.7	42.9	50.2	57.5	72.1
1.45	17 3/8	....	...	...	7.04	10.6	14.2	21.3	28.8	36.1	43.4	50.8	58.1	72.9
1.46	17 1/2	....	...	...	7.12	10.7	14.4	21.7	29.1	36.5	43.9	51.3	58.8	73.7
1.47	17 5/8	....	...	...	7.19	10.8	14.5	21.9	29.4	36.9	44.4	51.9	59.4	74.6
1.48	17 3/4	....	...	...	7.26	11.0	14.7	22.2	29.7	37.3	44.9	52.4	60.1	75.4
1.49	17 7/8	....	...	...	7.34	11.1	14.9	22.4	30.0	37.7	45.3	53.0	60.7	76.2
1.50	18	....	...	...	7.41	11.2	15.0	22.6	30.3	38.1	45.8	53.6	61.4	77.0
1.51	18 1/8	....	...	...	7.49	...	15.2	22.9	30.7	38.5	46.3	54.2	62.1	77.9
1.52	18 1/4	....	...	...	7.57	...	15.3	23.1	31.0	38.9	46.8	54.7	62.7	78.7
1.53	18 3/8	....	...	...	7.64	...	15.5	23.4	31.3	39.3	47.3	55.3	63.4	79.5
1.54	18 1/2	....	...	...	7.72	...	15.6	23.6	31.6	39.7	47.8	55.9	64.0	80.4
1.55	18 5/8	....	...	...	7.80	...	15.8	23.8	32.0	40.1	48.3	56.5	64.7	81.2
1.56	18 3/4	....	...	...	7.87	...	15.9	24.1	32.3	40.5	48.8	57.1	65.4	82.1

1.58	18 15/16	....	...	...	7.95	...	16.1	24.3	32.6	40.9	49.3	57.7	66.1	82.9
1.59	19 1/16	....	...	...	8.02	...	16.3	24.6	32.9	41.4	49.8	58.2	66.7	83.8
1.60	19 3/16	....	...	...	8.10	...	16.4	24.8	33.3	41.8	50.3	58.8	67.4	84.6
1.61	19 5/16	....	...	...	8.18	...	16.6	25.1	33.6	42.2	50.8	59.4	68.1	85.5
1.62	19 7/16	....	...	...	8.26	...	16.7	25.3	33.9	42.6	51.3	60.0	68.8	86.4
1.63	19 9/16	....	...	...	8.34	...	16.9	25.5	34.3	43.0	51.8	60.6	69.5	87.2
1.64	19 11/16	....	...	...	8.42	...	17.1	25.8	34.6	43.4	52.3	61.2	70.2	88.1
1.65	19 13/16	....	...	...	8.49	...	17.2	26.0	34.9	43.9	52.8	61.8	70.9	89.0
1.66	19 15/16	....	...	...	8.57	...	17.4	26.3	35.3	44.3	53.3	62.4	71.6	89.9
1.67	20 1/16	....	...	...	8.65	...	17.6	26.5	35.6	44.7	53.9	63.0	72.3	90.7
1.68	20 3/16	....	...	...	8.73	...	17.7	26.8	35.9	45.1	54.4	63.6	73.0	91.6
1.69	20 1/4	....	...	...	8.81	...	17.9	27.0	36.3	45.6	54.9	64.3	73.7	92.5
1.70	20 3/8	....	...	...	8.89	...	18.0	27.3	36.6	46.0	55.4	64.9	74.4	93.4
1.71	20 1/2	....	...	...	8.97	...	18.2	27.6	37.0	46.4	56.0	65.5	75.1	94.3
1.72	20 5/8	....	...	...	9.05	...	18.4	27.8	37.3	46.9	56.5	66.1	75.8	95.2
1.73	20 3/4	....	...	...	9.13	...	18.5	28.1	37.7	47.3	57.0	66.7	76.5	96.1
1.74	20 7/8	....	...	...	9.21	...	18.7	28.3	38.0	47.7	57.5	67.3	77.2	97.0
1.75	21	....	...	...	9.29	...	18.9	28.6	38.3	48.2	58.1	68.0	77.9	97.9
1.76	21 1/8	....	...	...	9.38	...	19.0	28.8	38.7	48.6	58.6	68.6	78.7	98.8
1.77	21 1/4	....	...	...	9.46	...	19.2	29.1	39.0	49.1	59.1	69.2	79.4	99.7
1.78	21 3/8	....	...	...	9.54	...	19.4	29.3	39.4	49.5	59.7	69.9	80.1	100.6
1.79	21 1/2	....	...	...	9.62	...	19.6	29.6	39.7	49.9	60.2	70.5	80.8	101.5
1.80	21 5/8	....	...	...	9.70	...	19.7	29.9	40.1	50.4	60.7	71.1	81.6	102.4
1.81	21 3/4	....	...	...	9.79	...	19.9	30.1	40.5	50.8	61.3	71.8	82.3	103.4
1.82	21 13/16	....	...	...	9.87	...	20.1	30.4	40.8	51.3	61.8	72.4	83.0	104.4
1.83	21 15/16	....	...	...	9.95	...	20.2	30.7	41.2	51.7	62.4	73.0	83.8	105.3
1.84	22 1/16	....	...	...	10.0	...	20.4	30.9	41.5	52.2	62.9	73.7	84.5	106.2
1.85	22 3/16	....	...	...	10.1	...	20.6	31.2	41.9	52.6	63.5	74.3	85.3	107.1
1.86	22 5/16	....	...	...	10.2	...	20.8	31.5	42.2	53.1	64.0	75.0	86.0	108.1
1.87	22 7/16	....	...	...	10.3	...	20.9	31.7	42.6	53.6	64.6	75.6	86.8	109.0
1.88	22 9/16	....	...	...	10.4	...	21.1	32.0	43.0	54.0	65.1	76.3	87.5	110.0
1.89	22 11/16	....	...	...	10.5	...	21.3	32.3	43.3	54.5	65.7	76.9	88.3	110.9
					10.5	...	21.5	32.5	43.7	54.9	66.3	77.6	89.0	111.9

Table 8 (*Concluded*). Free Flow Through Parshall Measuring Flumes

Head		Throat width												
Feet	Inches (approx.)	3″	6″	9″	1′	1.5′	2′	3′	4′	5′	6′	7′	8′	10′
		Flow in cubic feet per second												
1.90	22 13/16	....	...	...	10.6	...	21.6	32.8	44.1	55.4	66.8	78.2	89.8	112.9
1.91	22 15/16	....	...	...	10.7	...	21.8	33.1	44.4	55.9	67.4	78.9	90.5	113.8
1.92	23 1/16	....	...	...	10.8	...	22.0	33.3	44.8	56.3	67.9	79.6	91.3	114.8
1.93	23 3/16	....	...	...	10.9	...	22.2	33.6	45.2	56.8	68.5	80.2	92.1	115.8
1.94	23 1/4	....	...	...	11.0	...	22.4	33.9	45.5	57.3	69.1	80.9	92.8	116.7
1.95	23 3/8	....	...	...	11.1	...	22.5	34.1	45.9	57.7	69.6	81.6	93.6	117.7
1.96	23 1/2	....	...	...	11.1	...	22.7	34.4	46.3	58.2	70.2	82.2	94.4	118.7
1.97	23 5/8	....	...	...	11.2	...	22.9	34.7	46.6	58.7	70.8	82.9	95.1	119.7
1.98	23 3/4	....	...	...	11.3	...	23.1	35.0	47.0	59.1	71.4	83.6	95.9	120.6
1.99	23 7/8	....	...	...	11.4	...	23.2	35.3	47.4	59.6	71.9	84.3	96.7	121.6
2.00	24	....	...	...	11.5	...	23.4	35.5	47.8	60.1	72.5	84.9	97.5	122.6
2.01	24 1/8	....	...	...	11.6	...	23.6	35.8	48.1	60.6	73.1	85.6	98.3	123.6
2.02	24 1/4	....	...	...	11.7	...	23.8	36.1	48.5	61.0	73.7	86.3	99.1	124.6
2.03	24 3/8	....	...	...	11.8	...	24.0	36.4	48.9	61.5	74.2	87.0	99.8	125.6
2.04	24 1/2	....	...	...	11.8	...	24.2	36.7	49.3	62.0	74.8	87.7	100.6	126.6
2.05	24 5/8	....	...	...	11.9	...	24.3	36.9	49.7	62.5	75.4	88.4	101.4	127.6
2.06	24 3/4	....	...	...	12.0	...	24.5	37.2	50.1	63.0	76.0	89.1	102.2	128.6
2.07	24 13/16	....	...	...	12.1	...	24.7	37.5	50.4	63.5	76.6	89.8	103.0	129.6
2.08	24 15/16	....	...	...	12.2	...	24.9	37.8	50.8	63.9	77.2	90.4	103.8	130.6
2.09	25 1/16	....	...	...	12.3	...	25.1	38.1	51.2	64.4	77.8	91.1	104.6	131.6
2.10	25 3/16	....	...	...	12.4	...	25.3	38.4	51.6	64.9	78.4	91.8	105.4	132.7
2.11	25 5/16	....	...	...	12.5	...	25.5	38.6	52.0	65.4	79.0	92.5	106.2	133.7
2.12	25 7/16	....	...	...	12.6	...	25.6	38.9	52.4	65.9	79.6	93.3	107.0	134.7
2.13	25 9/16	....	...	...	12.6	...	25.8	39.2	52.8	66.4	80.2	94.0	107.9	135.7
2.14	25 11/16	....	...	...	12.7	...	26.0	39.5	53.2	66.9	80.8	94.7	108.7	136.8
2.15	25 13/16	....	...	...	12.8	...	26.2	39.8	53.5	67.4	81.4	95.4	109.5	137.8
2.16	25 15/16	....	...	...	12.9	...	26.4	40.1	53.9	67.9	82.0	96.1	110.3	138.8

2.17	26 1/16	....	...	...	13.0	...	26.6	40.4	54.3	68.4				
2.18	26 3/16	....	...	...	13.1	...	26.8	40.7	54.7	68.9				
2.19	26 1/4	....	...	...	13.2	...	27.0	41.0	55.1	69.4	83.8			
2.20	26 3/8	....	...	...	13.3	...	27.2	41.3	55.5	69.9	84.4	98.9	113.6	
2.21	26 1/2	....	...	...	13.4	...	27.3	41.5	55.9	70.4	85.0	99.7	114.4	144.1
2.22	26 5/8	....	...	...	13.5	...	27.5	41.8	56.3	70.9	85.6	100.0	115.3	145.1
2.23	26 3/4	....	...	...	13.6	...	27.7	42.1	56.7	71.4	86.3	101.1	116.1	146.2
2.24	26 7/8	....	...	...	13.7	...	27.9	42.4	57.1	71.9	86.9	101.8	116.9	147.3
2.25	27	....	...	...	13.7	...	28.1	42.7	57.5	72.4	87.5	102.6	117.8	148.3
2.26	27 1/8	....	...	...	13.8	...	28.3	43.0	57.9	72.9	88.1	103.3	118.6	149.4
2.27	27 1/4	....	...	...	13.9	...	28.5	43.3	58.3	73.5	88.7	104.0	119.5	150.5
2.28	27 3/8	....	...	...	14.0	...	28.7	43.6	58.7	74.0	89.4	104.8	120.3	151.5
2.29	27 1/2	....	...	...	14.1	...	28.9	43.9	59.2	74.5	90.0	105.5	121.2	152.6
2.30	27 5/8	....	...	...	14.2	...	29.1	44.2	59.6	75.0	90.6	106.2	122.0	153.7
2.31	27 3/4	....	...	...	14.3	...	29.3	44.5	60.0	75.5	91.2	107.0	122.9	154.8
2.32	27 13/16	....	...	...	14.4	...	29.5	44.8	60.4	76.0	91.9	107.7	123.7	155.8
2.33	27 15/16	....	...	...	14.5	...	29.7	45.1	60.8	76.6	92.5	108.5	124.6	156.9
2.34	28 1/16	....	...	...	14.6	...	29.9	45.4	61.2	77.1	93.1	109.2	125.4	158.0
2.35	28 3/16	....	...	...	14.7	...	30.1	45.7	61.6	77.6	93.8	110.0	126.3	159.1
2.36	28 5/16	....	...	...	14.8	...	30.3	46.0	62.0	78.1	94.4	110.7	127.2	160.2
2.37	28 7/16	....	...	...	14.9	...	30.5	46.4	62.4	78.7	95.1	111.5	128.0	161.3
2.38	28 9/16	....	...	...	15.0	...	30.7	46.7	62.9	79.2	95.7	112.2	128.9	162.4
2.39	28 11/16	....	...	...	15.1	...	30.9	47.0	63.3	79.7	96.3	113.0	129.8	163.5
2.40	28 13/16	....	...	...	15.2	...	31.1	47.3	63.7	80.3	97.0	113.7	130.7	164.6
2.41	28 15/16	....	...	...	15.3	...	31.3	47.6	64.1	80.8	97.6	114.5	131.5	165.7
2.42	29 1/16	....	...	...	15.4	...	31.5	47.9	64.5	81.3	98.3	115.3	132.4	166.8
2.43	29 3/16	....	...	...	15.5	...	31.7	48.2	65.0	81.8	98.9	116.0	133.3	167.9
2.44	29 1/4	....	...	...	15.6	...	31.9	48.5	65.4	82.4	99.6	116.8	134.2	169.1
2.45	29 3/8	....	...	...	15.6	...	32.1	48.8	65.8	82.9	100.2	117.6	135.1	170.2
2.46	29 1/2	....	...	...	15.7	...	32.3	49.1	66.2	83.5	100.9	118.3	135.9	171.3
2.47	29 5/8	....	...	...	15.9	...	32.5	49.5	66.7	84.0	101.5	119.1	136.8	172.4
2.48	29 3/4	....	...	...	15.9	...	32.7	49.8	67.1	84.5	102.2	119.9	137.7	173.6
2.49	29 7/8	....	...	...	16.0	...	32.9	50.1	67.5	85.1	102.8	120.6	138.6	174.7
2.50	30	....	...	...	16.1	...	33.1	50.4	67.9	85.6	103.5	121.4	139.5	175.8

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In order that the information in our publications may be more intelligible, it is sometimes necessary to use trade names of products and equipment rather than complicated descriptive or chemical identifications. In so doing, it is unavoidable in some cases that similar products which are on the market under other trade names may not be cited. No endorsement of named products is intended nor is criticism implied of similar products which are not mentioned.

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